[0079] Although the STA 306 has been the TWT requester in the aforementioned disclosure, in another configuration, the AP 302 may be the TWT requester and the STA 306 may be the TWT responder. In yet another configuration, the TWT setup and negotiation may occur between two STAs, such as the STAs 306, 308. STAs may perform TWT negotiation with each other when engaged in device-to-device communication such as in Tunneled Direct Link Setup (TDLS).

[0080] In an aspect, after TWT setup and negotiation, the STA 306 may not transmit a frame to the AP 302 during a trigger-enabled TWT service period (e.g., a TWT service period during which the AP 302 has indicated its intention to transmit a trigger frame by setting the trigger field of the TWT element exchanged during the TWT setup to 1) except when the frame is solicited by a trigger frame from the AP 302. However, if the STA 306 has data to transmit outside of a TWT SP, then the STA 306 may contend for the medium using lower priority enhanced distributed channel access (EDCA) parameters with respect to other STAs. Lower priority may be achieved, for example, by using EDCA parameters allocated to MU STAs or to TWT STAs. Such EDCA parameters may be associated with lower access categories such as access category best effort (AC_BE) or access category background (AC_BK), as opposed to the higher priority access categories such as access category video (AC_VI) or access category voice (AC_VO). In an aspect, the EDCA parameters may include a minimum contention window (CWMIN), a maximum contention window (CWMAX), an arbitration inter-frame spacing number (AIFSN), and/or a transmit opportunity (TXOP). The AC_BE and AC_BK access categories may have less favorable CWMIN, CWMAX, TXOP, and/or AIFSN values for medium contention.

[0081] Also, after the STA 306 negotiates an individual TWT session, the STA 306 may remain awake for at least an AdjustedMinimumTWTWakeDuration (e.g., a minimum time duration associated with a TWT service period) following the TWT start time to wait for a trigger message 316 from the AP 302. In another aspect, when the STA 306 transmits the frame during a trigger enabled TWT service period based on the trigger message 316, the STA 306 may be granted special medium access privileges (e.g., the STA 306 does not contend for the medium based on EDCA access categories or parameters when the transmitted frame is a response to a trigger frame).

[0082] In another aspect, after the STA 306 has negotiated an individual TWT session with the AP 302, the STA 306 may need not to read a beacon frame from the AP 302 because the STA 306 may not be expected to follow a broadcast TWT, which will be further discussed below.

[0083] In essence, the TWT operation as described offers several benefits. TWT operation improves channel contention because the wake times of STAs are either spread out for SU mode or concentrated within the same period of time to exchange frames in MU mode. STAs may wake up during scheduled target wake times and go to sleep outside of a TWT service period. TWT operation also reduces power expenditure because DL/UL frame exchange airtime is reduced.

[0084] Additionally, although the aforementioned signaling has been discussed with respect to the TWT element (e.g., the TWT element 200 in FIG. 2), similar signaling may be utilized in a RAW parameter set (RPS). For example, an RPS may include one or more RAW start time fields and a trigger field. The trigger field in the RPS may indicate whether a trigger frame is to be transmitted at the start of the RAW.

[0085] Although FIG. 2 and the aforementioned description disclose a single TWT in the TWT element 200, the TWT element 200 may include one or more TWTs by adjusting the value of the length field of the TWT element 200. Thus, different TWT flows may be associated with different device target wake times. Furthermore, the TWT element 200 may schedule additional TWTs on a periodic basis. For example, a next scheduled TWT may be implicitly calculated when the implicit field, as discussed above, is set to 1. The next scheduled TWT may be calculated based on the scheduled TWT plus a multiple of the TWT wake interval. In this aspect, a scheduled TWT may be associated with multiple later occurring scheduled TWTs, and the scheduled TWT may be associated with a corresponding TWT service period and with multiple later occurring TWT service periods associated with the later occurring scheduled TWTs.

[0086] FIG. 4 is a flowchart of an example method 400 of requesting TWT scheduling. The method 400 may be performed using an apparatus (e.g., the AP 302, the STA 306, or the wireless device 1302, *infra,* for example). Although the method 400 is described below with respect to the elements of wireless device 1302 of FIG. 13, *infra,* other components may be used to implement one or more of the steps described herein.

[0087] At block 405, the apparatus may transmit a first message that includes a first trigger field to a second wireless device. The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the second wireless device at a start of a TWT service period For example, referring to FIG. 3, the apparatus may be the STA 306, and the second wireless device may be the AP 302. The STA 306 may transmit the first message 312 that includes the first trigger field to the AP 302. The first trigger field has a value of 1, indicating that the first message 312 includes a request for a trigger frame to be sent by the AP 302. In this example, the first trigger field having a value of 1 is (or indicates) a request for a trigger frame. The first message 312 also includes a suggested TWT of a TWT service period. In another example, the requested TWT may be a null value, indicating that no specific time is requested for TWT and that the AP 302 is free to select a scheduled TWT time. In an aspect, the first message 312 may include a TWT channel field that indicates a channel and a channel width that the STA 306 may use for communicating with the AP 302 during the TWT service period.

[0088] At block 410, the apparatus may receive a second message from the second wireless device. The second message may include TWT parameters and a second trigger field based on the first message, and the second trigger field may indicate whether the second wireless device will transmit the trigger message at the start of the TWT service period. For example, referring to FIG. 3, the STA 306 may receive the second message 314 from the AP 302. The second message 314 may include one or more fields (TWT parameters) in a TWT element and a second trigger field based on the first message 312. The second trigger field may have a value of 1, indicating that the AP 302 will transmit the trigger frame at a scheduled TWT of the TWT service period. In an aspect, the scheduled TWT value is later than the requested TWT value in the first message 312. Moreover, the first message 312 may include an OFDMA bitmap that indicates one or more OFDMA channels and channel widths, associated with the channels indicated in the TWT channel, for communicating with the STA 306.

[0089] At block 415, the apparatus may determine a TWT schedule based on the received second message. The apparatus may determine the TWT schedule by determining whether the TWT schedule is an implicit TWT schedule or an explicit TWT schedule based on the received second message and by determining one or more TWTs associated with the TWT schedule based on the received second

message. For example, referring to FIG. 3, the STA 306 may determine whether the second message 314 indicates an implicit or explicit TWT schedule based on whether the implicit field is set to 1 (implicit TWT) or to 0 (explicit TWT). If the TWT schedule is implicit, then the STA 306 may determine one or more TWTs associated with the TWT schedule based on a TWT value included in the second message 314 and based on a TWT wake interval mantissa and a wake interval exponent included in the second message 314. By contrast, if the TWT schedule is an explicit TWT schedule, then the STA 306 may determine one or more TWTs based on the TWTs included in the second message 314.

[0090] At block 420, the apparatus may determine whether to transmit to the second wireless device based on the determined TWT schedule. In one configuration, the apparatus may determine whether to transmit by determining to transmit during the TWT service period only when a trigger message is received from the second wireless device or by determining to transmit outside of the TWT service period based on EDCA parameters associated with a best effort access category (AC_BE) or a background access category (AC_BK). For example, referring to FIG. 3, the STA 306 may determine whether to transmit to the AP 302 based on the determined TWT schedule. If the STA 306 wants to transmit during a TWT service period associated with the determined TWT schedule, then the STA 306 may wait for the trigger message 316 from the AP 302 before transmitting to the AP 302. If the STA 306 transmits during the TWT service period based on the trigger message 316, the STA 306 may not need to contend for the medium using EDCA. If the STA 306 does not receive the trigger message 316, then the STA 306 may refrain from transmitting during the TWT service period. In another aspect, if the STA 306 has data for transmission outside of the TWT service period, then the STA may transmit based on an EDCA contention for lower priority EDCA parameters associated with a best effort access category.

[0091] At block 425, the apparatus may receive a trigger message based on the determined TWT schedule. The trigger message may include a cascaded indicator that indicates whether the second wireless device will transmit another trigger message after the trigger message in the TWT service period. For example, referring to FIG. 3, the STA 306 may receive the trigger message 316 based on the determined TWT schedule. The trigger message 316 may include a cascaded

indicator set to 0 that indicates the AP 302 will not transmit another trigger message in the TWT service period.

[0092] At block 430, the apparatus may receive a TWT information message from the second wireless device. The TWT information message may include a next TWT value. For example, referring to FIG. 3, the STA 306 may receive a TWT information message from the AP 302. In an aspect, the TWT schedule may be an implicit TWT schedule, and the TWT information message may indicate a different next TWT than what is implied based on the TWT schedule. In another aspect, the TWT schedule may be an explicit TWT schedule indicated by the second message 314, and the TWT information message may indicate a next TWT value that is different from the TWT values indicated in the second message 314.

[0093] At block 435, the apparatus may update the TWT schedule based on the received TWT information message. For example, referring to FIG. 3, the STA 306 may store and associate the new next TWT value with the determined TWT schedule.

[0094] At block 440, the apparatus may transmit a TWT information message to the second wireless device. The TWT information message may indicate a suspension of an implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. For example, referring to FIG. 3, if the TWT agreement between the STA 306 and the AP 302 is an implied TWT schedule, and the STA 306 no longer has data to transmit, then the STA 306 may transmit a TWT information message to the AP 302 signaling a suspension of the implicit TWT schedule. Subsequently, when the STA 306 has data to transmit, the STA 306 may transmit a second TWT information message to the AP 302 to indicate a resumption of the suspended TWT schedule.

[0095] Although the aforementioned examples describe a STA as an apparatus performing the steps in the method 400, an AP may also perform the steps of the method 400. That is, the AP may be the TWT requester and the STA may be the TWT responder. In another aspect, STAs may be engaging in device-to-device communications, and one STA may be the TWT requester and another STA may be the TWT responder.

[0096] FIG. 5 is a flowchart of an example method 500 of responding to a request for, or of transmitting information related to, TWT scheduling. The method 500 may be performed using an apparatus (e.g., the STA 306, the AP 302, or the wireless device 1302, *infra*, for example). Although the method 500 is described below with respect

to the elements of wireless device 1302 of FIG. 13, *infra,* other components may be used to implement one or more of the steps described herein.

[0097] At block 505, the apparatus may receive, from a second wireless device, a first message that includes a first trigger field. The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the apparatus at a start of a TWT service period. For example, referring to FIG. 3, the apparatus may be the AP 302 and the second wireless device may be the STA 306. The AP 302 may receive the first message 312 from the STA 306. The first message 312 may include a first trigger field set to 1, indicating that the first message 312 requests a trigger frame to be sent by the AP 302. The first message 312 may further include at a requested TWT for the STA 306.

[0098] At block 510, the apparatus may determine a TWT schedule based on the received first message. The apparatus may determine the TWT schedule by determining if the first trigger field in the first message includes a request for the trigger message and by scheduling one or more TWTs for the second wireless device if the trigger field includes the request for the trigger message. For example, referring to FIG. 3, the AP 302 may determine whether to send a trigger frame to the STA 306 by determining that the first message 312 includes the first trigger field set to 1 and by scheduling a TWT for the STA 306. The scheduled TWT may be for an implicit TWT. In an aspect, the AP 302 may determine the TWT based on the expected traffic on the wireless medium.

[0099] At block 515, the apparatus may transmit a second message to the second wireless device. The second message may include the TWT schedule and a second trigger field based on the determined TWT schedule. The second trigger field may indicate whether the apparatus will transmit the trigger message at the start of the TWT service period. In one example, referring to FIG. 3, the AP 302 may transmit the second message 314 to the STA 306. The second message 314 may include the TWT schedule and a second trigger field having a value of 1 based on the determination to send a trigger frame to the STA 306. The second message 314 may also indicate that the trigger frame will be transmitted at the scheduled TWT, which is different from the requested TWT in the first message 312.

[00100] At block 520, the apparatus may transmit a trigger message that includes a cascaded indicator. The cascaded indicator may indicate whether the apparatus will transmit another trigger message after the trigger message in the TWT service

period. For example, referring to FIG. 3, the AP 302 may transmit the trigger message 316 that includes a cascaded indicator. The cascaded indicator may be set to 1 and indicate that the AP 302 will transmit another trigger message within the same TWT service period as the trigger message 316.

[00101] At block 525, the apparatus may transmit a TWT information message that includes a next TWT value that is different from all TWT values associated with the TWT schedule included in the second message. For example, referring to FIG. 3, the AP 302 may transmit a TWT information message that includes a next TWT value that is different from the TWT values associated with the implicit TWT schedule included in the second message 314. Alternatively, if the TWT schedule is an explicit TWT schedule, the AP 302 may transmit a TWT information message that includes a next TWT value that is different from the TWT values associated with the explicit TWT schedule.

[00102] At block 530, the apparatus may receive a TWT information message from the second wireless device. The TWT information message may indicate a suspension of an implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. For example, referring to FIG. 3, the AP 302 may receive a TWT information message from the STA 306. The TWT information message may indicate that the STA 306 wants to suspend the implicit TWT schedule. In another example, if the implicit TWT schedule has already been suspended, the AP 302 may receive a TWT information message from the STA 306 indicating a request to resume the implicit TWT schedule.

[00103] Although the aforementioned examples describe an AP as an apparatus performing the steps in the method 500, a STA may also perform the steps of the method 500. That is, the AP may be the TWT requester and the STA may be the TWT responder. In another aspect, STAs may be engaging in device-to-device communications, and one STA may be the TWT requester and another STA may be the TWT responder.

[00104] Broadcast TWT Scheduling

[00105] FIG. 6 is an exemplary diagram 600 of a wireless network implementing broadcast TWT scheduling and an exemplary timing flow diagram 650 for TWT operation. The diagram illustrates an AP 602 broadcasting or transmitting within a BSA 604. STAs 606, 608, 610 are within the BSA 604 and are served by the AP 602. The STAs 606, 608, 610 and the AP 602 may perform non-negotiable TWT

scheduling. In an aspect, wireless devices may optionally negotitate TBTTs during TWT setup.

[00106] In broadcast TWT scheduling, the delivery of TWT schedules may occur without a negotiation between devices. The AP 602 may determine 612 a TWT schedule for communicating with one or more STAs. The AP 602 may determine the TWT schedule by determining that the AP 602 has data to transmit to the STAs (e.g., buffer approaching capacity or buffered units available for delivery), that the STAs 606, 608, 610 have data to transmit to the AP 602, and/or that an access medium is available. Based on such buffer status and network conditions, the AP 602 may schedule one or more wake up times for the STAs 606, 608, 610 after which the AP 602 may transmit trigger frames to enable communication. The AP 602 may indicate an intention to transmit one or more trigger frames in a first message 614 (e.g., a beacon frame transmitted at or after a scheduled TBTT (in an aspect, the TBTT may be negotiated between wireless devices) or a management message intended for one or more STAs) that is received by the STAs 606, 608, 610 at a given instant of time. The TBTT may correspond to the time when a beacon carrying the TWT element containing a broadcast TWT is scheduled to be delivered. The first message 614 may include a TWT element (e.g., the TWT element 200 illustrated in FIG. 2). The first message 614 may include a first element ID identifying the TWT element 200 and one or more TWT parameter sets as described below (see, for example, FIG. 16). In the description below, details are provided to the signaling contained in one of these TWT parameter sets. The first message 614 may include a first TWT request field having a value of 0 to indicate that the TWT element is not a request (a TWT request field with a value of 0 indicates that the TWT element is a response or is not request). The first message 614 may indicate one or more scheduled TWTs (either explicitly or implicitly, as discussed above) that indicate when STAs should wake up. The one or more scheduled TWTs may not be part of a TWT negotiation; that is, the STAs 606, 608, 610, upon receiving the first message 614, may not be able to negotiate for a different scheduled TWT. Further, the STAs 606, 608, 610 may also not be able to negotiate other parameters within the TWT element. The one or more scheduled TWTs may be included in the TWT field(s) or other field(s) within the TWT element. The first message 614 may include a first trigger field with a value of 1 to indicate that one or more trigger frames will be sent during one or more TWT service periods associated with the one

or more scheduled TWTs. In other words, the first message 614 may indicate to STAs that during the TWT service period 1, the STAs may have a scheduled TWT and a trigger frame may be sent at the scheduled TWT. The first message 614 may further indicate that other trigger frames may be sent during subsequent TWT service periods (e.g., TWT service period 2). The first message 614 may include a broadcast indicator/subfield), which may be a bit that is included in the control field or some other field within the TWT element. In one aspect, the broadcast indicator may be set to 1 to indicate the first message 614 includes a TWT element with non-negotiable parameters (e.g., the TWT element is a broadcast TWT element). In another aspect, the broadcast indicator may be set to 0 to indicate the first message 614 includes a TWT element with negotiable parameters, in which case the TWT element may be associated with a solicit TWT as discussed above. In another aspect, the broadcast indicator may be based on a value of the TWT setup command subfield of the request type field. For example, when the TWT setup command subfield is set to a certain value which is any value less than 3, and the TWT request field is set to 0, then the first message 614 is a non-negotiable TWT scheduling message.

[00107] When a TWT element is transmitted in the first message 614, the first message 614 may include any one of the fields in the TWT element (e.g., the TWT element 200 in FIG. 2). The TWT element may include multiple groups of fields (or TWT parameter sets), and each group of fields (or TWT parameter) may correspond to a single given scheduled TWT. For example, a TWT element may include multiple scheduled TWTs, and each TWT may be associated with a separate group of TWT fields (e.g., request type, target wake time, TWT group assignment field, etc.) as depicted in FIG. 16. In another aspect, instead of having two or more groups of fields within a single TWT element when multiple TWTs are transmitted within the first message 614, the AP 602 may include multiple TWT elements within the first message 614, and each TWT element may include one TWT and an associated group of TWT fields.

[00108] Referring to FIG. 2, the target wake time field may be 8 octets or less. In an aspect, when the AP 602 broadcasts the TWT element in the first message 614, the AP 602 may determine to use less than 8 octets to indicate the scheduled TWT to save space. In an aspect, assuming the AP 602 and the STAs 606, 608, 610 are already time synchronized (e.g., the beacon carrying the TWT element already

carries the TSF timer in the timestamp field), the TWT field may indicate the least significant octets of the binary value that the timing synchronization function (TSF) timer will have at the scheduled TWT. For example, the TWT field may use the 3 least significant bytes to indicate the scheduled TWT. In another aspect, the TWT field may include even less bits if the AP 602 wants to provide less resolution for the TWT (e.g., 10 μs rather than 1 μs which would be the resolution of a generic TSF timer for wireless devices). In yet another aspect, the TWT field may be used to indicate an estimated time at which the trigger frame may be sent or an estimated time for the scheduled TWT relative to the end of the first message 614. For example, if the TWT field has a value of 100 ms, that may indicate to the STAs 606, 608, 610 to wake up 100 ms after the last field of the first message 614 is received, or may indicate to the STAs 606, 608, 610 that the trigger frame may be received by the STAs 606, 608, 610 approximately 100 ms after the STAs 606, 608, 610 received the entirety of first message 614. In yet another aspect, the subset of bits in the TWT field may be a shifted subset of the bits corresponding to the TSF timer. For example, assuming the TSF timer has 8 bytes. Instead of including the least significant 3 bytes, the subset may be shifted in which the TWT field includes the second, third, and fourth least significant bytes of the 8 byte representation of the TSF timer. In certain embodiments, the bit shifting may occur at the bit level rather than the byte level.

[00109] In another aspect, when the TWT element is included in the first message 614, the TWT wake interval may be valid only for the beacon interval that follows the first message 614 that is sent at the beginning of the beacon interval. In another aspect, the TWT wake interval may be valid for the delivery traffic indication map (DTIM) interval if the first message 614 that includes the TWT element is a DTIM beacon. In another aspect, the TWT wake interval may be valid for the duration of the existence of the basic service set. That is, the TWT wake interval may be valid so long as the STA remains associated with the AP.

[00110] In another aspect, the TWT element may include a flow identifier (e.g., one or more of the TWT flow identifier fields in the requests field or another field in the groups of fields of the TWT element) that indicates one or more types of allowed data flows. In one configuration, if the TWT flow identifier may have a value of 0, then the trigger frame associated with the first message 614 may be for wild card (or random) access from unassociated STAs. If an unassociated STA wants to send an

association request or a probe request to the AP 602, for example, unassociated STAs may wake up at the scheduled TWT indicated in the first message 614 and randomly select a subchannel/subband to transmit the association request/probe request using on a random back off or another collision avoidance mechanism. If the TWT flow identifier has a value of 1, then the trigger frame associated with the first message 614 may be for wild card access from associated STAs. For example, if the STA 606 receives the first message 614 in a broadcast, the STA 606 may determine to wake up at the one or more scheduled TWTs indicated in the first message 614. The STA 606 may receive one or more trigger messages at the one or more scheduled TWTs and transmit uplink data to the AP 602 after receiving the one or more trigger messages. If the TWT flow identifier has a value of 2, associated STAs in power save mode may transmit upon receiving the trigger frame at the scheduled TWT. If the TWT flow identifier has a value of 3, associated STAs may transmit voice traffic upon receiving the trigger frame at the scheduled TWT. If the TWT flow identifier has a value of 4, associated STAs may transmit video traffic upon receiving the trigger frame at the scheduled TWT.

[00111] In another configuration, the types of allowed data indicated by the TWT flow identifier may include: multi-user OFDMA random access for unassociated STAs, multi-user OFDMA random access for associated STAs, multi-user downlink OFDMA scheduled access for TIM STAs, multi-user uplink OFDMA scheduled access for TIM STAs, multi-user uplink MIMO scheduled access for TIM STAs, and/or multi-user downlink MIMO scheduled access for TIM STAs.

[00112] In the first category, multi-user OFDMA random access for unassociated STAs, only unassociated STAs may transmit data to the AP 602 following the reception of the trigger frame sent at the one or more scheduled TWTs during the TWT service periods by the AP 602. The frames that can be sent by the unassociated STAs may include a probe request, an association request, a reassociation request, an authentication request, etc. The frames may be sent in any OFDMA resource following a random access procedure for selecting the OFDMA resource for transmission. Regarding the random access procedure, one or more unassociated STAs may randomly select an OFDMA channel for transmitting the frames. The unassociated STAs may coordinate with each other such that if two or more unassociated STAs randomly select the same OFDMA channel, the unassociated

STAs will randomly select another OFDMA channel until each unassociated STA has selected a different OFDMA channel.

[00113] In the second category, multi-user OFDMA random access for associated STAs, only associated STAs (STAs 606, 608, 610) may transmit following the reception of a trigger frame sent by the AP 602 during a TWT service period associated with the one or more scheduled TWTs. The frames that can be sent by the associated STAs may be any frame. The frames may be PS-Poll or APSD trigger frames, or any other frame that can be used to indicate to the AP 602 that the buffer status and/or transmission preferences of the associated STAs. Transmission preferences may include a preferred MCS, bandwidth, subchannel, etc.

[00114] In the third category, multi-user downlink OFDMA scheduled access for TIM STAs, only STAs for which an association identifier (AID) corresponds to a value of 1 in a traffic information map (TIM) element bitmap included in a beacon message (e.g., the first message 614) carrying the TWT element may receive data from the AP 602 after receiving the trigger frame that is sent at the scheduled TWT or during the TWT service period. In certain embodiments, instead of transmitting a trigger frame, the AP 602 may transmit downlink data to the STAs in multi-user OFDMA. The AP 602 may also indicate in the trigger frame uplink OFDMA resources associated with each STA to be used within the same scheduled TWT or TWT service period.

[00115] In the fourth category, multi-user uplink OFDMA scheduled access for TIM STAs, only STAs for which an AID corresponds to a value of 1 in the TIM element bitmap included in a beacon message (e.g., the first message 614) carrying the TWT element may transmit data after receiving the trigger frame that is sent at the scheduled TWT during the TWT service period. The AP 602 may indicate that the TWT service period is allocated for uplink transmission only. The AP 602 may decide to transmit downlink data to the STAs after terminating the first trigger-enabled exchange.

[00116] In the fifth and sixth categories, multi-user uplink MIMO scheduled access for TIM STAs and multi-user downlink MIMO scheduled access for TIM STAs, APs and STAs whose AID bit is 1 in the TIM element may exchange downlink and uplink data using multi-user MIMO. As previously indicated other fields, not just the TWT flow identifier field, may indicate the allowed data categories. For

example, the TWT wake interval exponent subfield may be overloaded to signal the allowed data types instead of the TWT flow identifier field.

[00117] In another aspect, a flow identifier may be used to indicate a traffic class or traffic identifier (TID) that identifies a type of traffic allowed to be exchanged during the TWT service period. For example, as discussed previously, the flow identifier may be used to indicate the types of flows that may be allowed in response to a trigger frame. The traffic type may include voice and video traffic.

[00118] When the STA 606 receives the first message 614, the STA 606 may determine whether to be awake during the one or more TWT service periods associated with the one or more scheduled TWTs included in the first message 614. The STA 606 may determine whether to be awake during the one or more TWT service periods by determining whether the STA 606 has data to transmit to the AP 602 and by determining whether the STA 606 expects to receive data from the AP 602.

[00119] During a TWT service period associated with the scheduled TWT included in the first message 614 in which a trigger frame is expected, the STAs 606, 608, 610 may not contend for access to the medium for data transmission. Instead, the STAs 606, 608, 610 may wait to receive a trigger frame 616 sent by the AP 602 that enables the STAs 606, 608, 610 to transmit data frames. The data frames may be sent in either single user or multi-user mode.

[00120] Assuming the STA 606 determines to participate in TWT scheduling, upon receiving the trigger frame 616, the STA 606 may transmit data 618 to or receive data 618 from the AP 602. The data 618 may be transmitted during the TWT service periods. STAs (e.g., the STA 606) that fail to transmit after the trigger frame 616 may transmit after the TWT service period ends. The transmission may be a retransmission of a failed transmission or it may be a resource allocation request.

[00121] FIG. 7 is a flowchart of an example method 700 of broadcast TWT scheduling. The method 700 may be performed using an apparatus (e.g., the AP 602, the STA 606, or the wireless device 1302, *infra,* for example). Although the method 700 is described below with respect to the elements of wireless device 1302 of FIG. 13, *infra,* other components may be used to implement one or more of the steps described herein.

[00122] At block 705, the apparatus may determine a TWT schedule for other wireless devices. The apparatus may determine the TWT schedule by determining one or more fields within the TWT element. In an aspect, the apparatus may determine

network conditions (e.g., a number of wireless devices expected to communicate with the apparatus and/or an amount of traffic on the wireless medium). For example, referring to FIG. 6, the AP 602 may determine a broadcast TWT schedule for one or more STAs. The broadcast schedule may include non-negotiable TWT parameters for communicating with the AP 602. The AP 602 may determine the broadcast TWT schedule by determining whether to utilize an implicit TWT schedule or an explicit TWT schedule. Further, the one or more TWTs associated with the broadcast TWT schedule. The AP 602 may determine any of the other fields or parameters associated with the TWT element (e.g., the TWT element 200).

[00123] At block 710, the apparatus may broadcast a message that includes the TWT schedule to a plurality of wireless devices. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. In an aspect, the message may include a trigger field that indicates whether the apparatus will transmit a trigger message at a start of or during a TWT service period. The message may further include a TWT flow identifier that indicates a type of data flow allowed during the TWT service period. For example, referring to FIG. 6, apparatus may be the AP 602. The AP 602 may broadcast the first message 614 that includes a TWT schedule. The broadcast bit in the first message 614 may be set to 1, indicating that the TWT schedule is a broadcast TWT. The first message 614 may also include a trigger field set to 1, indicating that the AP 602 will transmit a trigger frame during the TWT service period. The first message 614 may include an implicit field set to 0, indicating that the TWT schedule is an explicit TWT schedule. The first message 614 may further include 4 scheduled TWTs associated with 4 TWT parameter sets. In an aspect, the first message 614 may include a repetition indicator that indicates that the TWT schedule is valid for 5 TWT service periods. In another aspect, the first message 614 may include a TWT protection indicator set to 1, indicating that messages exchanged between the STA 606 and the AP 602 are to be preceded by a RTS message from the transmitter and a CTS message from the receiver.

[00124] At block 715, the apparatus may transmit a trigger message based on the TWT schedule. The trigger message may include a cascaded indicator that indicates whether the apparatus will transmit additional trigger messages in a TWT service period. For example, referring to FIG. 6, the AP 602 may transmit the trigger frame 616. In an aspect, for MU operation, the AP 602 may transmit multiple trigger

frames within a TWT service period to enable multiple STAs to transmit to the AP 602. As such, the AP 602 may transmit the trigger frame 616 addressed to STAs 606, 608 with a cascaded indicator set to 1 to indicate that the AP 302 will transmit another trigger frame within the same TWT service period. The STAs 606, 608 may transmit uplink data to the AP 602 based on the trigger frame 616. Subsequently, the AP 602 may transmit another trigger frame addressed to the STAs 608, 610 to indicate resources for another uplink transmission.

[00125] At 720, the apparatus may transmit a TWT information message to the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. For example, referring to FIG. 6, the AP 602 may transmit a TWT information message to the STAs 606, 608, 610 indicating a suspension of the broadcast TWT schedule indicated in the first message 614 if the broadcast TWT schedule is an implicit TWT schedule. In an aspect, the implicit TWT schedule may be suspended based on network conditions, lack of data for transmission, or to conserve power. In another aspect, to resume a previously suspended implicit TWT schedule, the AP 602 may transmit a TWT information message to the STAs 606, 608, 610 indicating a resumption of a suspended TWT schedule.

[00126] At block 725, the apparatus may transmit a TWT information message to the second wireless device. The TWT information message may indicate a different scheduled TWT than in the broadcasted message. For example, referring to FIG. 6, the AP 602 may transmit a TWT information message to the STAs 606, 608, 610 that indicates a different scheduled TWT than what has been implied in the implicit TWT schedule. In another example, if the TWT schedule is an explicit TWT schedule, then the TWT information message may include a different scheduled TWT than the TWTs indicated in the explicit TWT schedule in the first message 614.

[00127] Although the aforementioned example provides that an AP broadcasts a TWT schedule, the STA may broadcast a TWT schedule to an AP or to another STA.

[00128] FIG. 8 is a flowchart of an example method 800 of communicating based on broadcast TWT scheduling. The method 500 may be performed using an apparatus (e.g., the STA 606, or the wireless device 1302, *infra,* for example). Although the method 800 is described below with respect to the elements of wireless device 1302

of FIG. 13, *infra*, other components may be used to implement one or more of the steps described herein.

[00129] At block 805, the apparatus may receive from a second wireless device a message that includes a TWT schedule. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. For example, referring to FIG. 6, the apparatus may be the STA 606. The STA 606 may receive from the AP 602 the first message 614 that include a TWT schedule. The first message 614 may include a broadcast indicator set to 1, indicating that the TWT schedule is a broadcast schedule. The first message 614 may include a trigger field set to 1, indicating that the AP 602 will transmit the trigger frame 616 at the start of or during the TWT service period. The first message 614 may further include a TWT flow identifier set to 1, indicating that there are no constraints on the types of frames or messages during the broadcast TWT service period.

[00130] At block 810, the apparatus may determine one or more TWTs for the apparatus based on the TWT schedule. The apparatus may determine one or more TWTs by determining if the TWT schedule is an implicit or explicit TWT schedule. If the TWT schedule is an implicit TWT schedule, then the apparatus may determine one or more TWTs based on the first TWT indicated in the TWT schedule. Subsequent TWT may be determined based on the TWT wake interval mantissa and on the wake interval exponent, which may be indicated in the message or preconfigured at the apparatus. If the TWT schedule is an explicit TWT schedule, then the apparatus may extract the one or more TWTs from the received message. For example, referring to FIG. 6, the STA 606 may determine whether the TWT schedule indicated in the first message 614 in an implicit or explicit TWT schedule, and either calculate or extract the TWT values based on the determination.

[00131] At block 815, the apparatus may receive a trigger message based on the determined one or more TWTs. For example, referring to FIG. 6, the STA 606 may receive the trigger frame 616 based on the determined one or more TWTs.

[00132] At block 820, the apparatus may determine to transmit to the second wireless device during a TWT service period when the trigger message is received from the second wireless device. For example, referring to FIG. 6, the STA 606 may determine to transmit to the AP 602 by determining that data is available for transmission to the AP 602, by determining that the data may be transmitted during

the TWT service period, and by determining that the trigger frame 616 has been received from the AP 602.

[00133] At block 825, the apparatus may determine to transmit to the second wireless device outside of the TWT service period based on EDCA parameters associated with AC_BE or AC_BK. For example, referring to FIG. 6, the STA 606 may determine that data is available for transmission to the AP 602, and either no trigger frame has been received from the AP 602 or the data cannot wait for the next available TWT service period. As such, the STA 606 may determine to transmit to the AP 602 by contending for medium access based on a lower priority EDCA access category, AC_BE.

[00134] At block 830, the apparatus may receive a TWT information message from the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. For example, referring to FIG. 6, the STA 606 may receive a TWT information message from the AP 602, indicating a suspension of the implicit TWT schedule or a resumption of the suspended, implicit TWT schedule.

[00135] At block 835, the apparatus may receive a TWT information message from the second wireless device. The TWT information message may indicate a different scheduled TWT than in the received message. For example, referring to FIG. 6, the STA 606 may receive a TWT information message from the AP 602, and the TWT information message may indicating a different scheduled TWT than the TWT indicated in the first message 614.

[00136] TWT Power Save Mode

[00137] In future IEEE 802.1 1 standards, an AP may send trigger frames to solicit uplink data frames from and/or transmit downlink data frames to one or more STAs in multi-user mode. In general, trigger frames may be generated by the AP any time. A STA that intends to transmit uplink data may have to stay awake to receive the trigger frame intended for the STA. However, staying awake during periods when no trigger frame will be sent may lead to unnecessary power consumption as the AP can scheduled multiple trigger frames for multiple STAs. One way to resolve this issue is to allow the STA and the AP to negotiate target trigger transmit times, as discussed previously, so that the STA knows when the trigger frame(s) will arrive.

These transmit times may be negotiated (solicit TWT or unsolicit TWT) to be periodic or aperiodic or may not be non-negotiated (broadcast TWT).

[00138] In certain instances, the scheduled TWTs may dynamically change between a periodic partem to an aperiodic partem based on a partem indication by either the AP or the STA. The pattern indication may be indicated by an implicit field that is contained in the message carrying the trigger field. The implicit field may be set to 1 to indicate that the partem is periodic and may be set to 0 to indicate that the pattern is aperiodic.

[00139] When the pattern is aperiodic, the next TWT may be explicitly signaled by a TWT responder (e.g., an AP). In an aspect, the TWT responder may transmit a TACK/STACK/BAT or TWT information frames to signal the next TWT. These frames may contain the value of the next TWT and the TWT flow identifier that identifies the TWT flow to which the next TWT corresponds to in the case of a solicit TWT agreement. The TWT requester may request a change of partem for the next TWT by sending a TACK/STACK/BAT frame that carries a next TWT field. The TWT requester may confirm the new schedule in a successive frame that contains a Next TWT field (TACK/STACK/BAT etc).

[00140] When the pattern is periodic the TWT responder does not provide the next TWT during a current TWT service period. Instead the TWT requester implicitly calculates the next TWT every TWT service period based on the value of the TWT at the current TWT service period plus the value of the negotiated TWT wake interval as specified in the negotiation period of the TWT. During a periodic TWT (i.e., implicit TWT) either of the devices may request a rescheduling of the parameters for a given TWT flow. This may be performed by sending a request or response with updated parameters anytime during a TWT service period. The request or response in this case may have a dialog token that is equal to the dialog token value exchanged during the TWT setup. Similarly, the request or response may contain the TWT Flow Identifier for which the rescheduling is requested. The request may be confirmed, an alternative may be provided, or the request may be refused. In certain embodiments a response to re-negotiate the parameters may be non-negotiable and to take effect starting from the next TWT.

[00141] In certain cases, even though the AP and the STA may have an agreement (e.g., a schedule) for exchanging uplink/downlink frames following the trigger frame in a periodic pattern (e.g., during the TWT service periods), there may be periods of time

where one of the STAs does not expect traffic for a long period of time. As such, a need exists to enable to STA to indicate a suspension of the agreed upon schedule for a given amount of time. This way, the STA does not need to wake up during certain TWT service periods at which the STA has no uplink data to transmit to the AP. Also in certain cases, the AP does not plan to use the full TWT service period for sending trigger frames, and, as such, the AP may want to indicate an early termination of a given TWT service period.

[00142] FIG. 9 is an exemplary diagram 900 of a wireless network supporting power save modes for TWT scheduling and an exemplary timing flow diagram 950 for TWT operation. The diagram illustrates an AP 902 broadcasting or transmitting within a BSA 904. STAs 906, 908, 910 are within the BSA 904 and are served by the AP 902.

[00143] In one configuration, the STA 906 (or any other STA) may be in one of two different power states: an awake state and a doze (or sleep) state. In the awake state, the STA is fully powered. In the doze state, the STA 906 may not able to transmit or receive data and may consume very little power. The STA 906 may transition between the awake state and the doze state based on power management modes—active mode (AM) and power save (PS) mode. In the active mode, the STA 906 may be in a continually awake state. In the PS mode, the STA 906 is in a doze state and may enter the awake state to receive selected beacons, to receive group addressed transmissions following certain received beacon frames, to receive transmissions during the service period of a scheduled groupcast with retries service period (GCR-SP), to transmit, or to wait for responses to transmitted PS-poll frames or to receive contention free (CF) transmission of data.

[00144] To change power management modes, the STA 906 may inform the AP 902 through a successful frame exchange that is initiated by the STA 906. The frame may be a management, extension, or data frame and may include an acknowledgment (ACK) or a BlockACK frame from the AP 902. The frame may include a power management subfield(s) in the frame control field, and the power management subfield may indicate the power management mode that the STA 906 may adopt upon successful completion of the entire frame exchange (e.g., frame and acknowledgment). The STA 906 may not change power management mode using a frame exchange that does not receive an ACK or a BlockACK frame from the AP 902, or using a BlockACKReq frame. When the AP 902 receives the frame from

the STA 906 indicating a mode change, the AP 902 may store the new power management mode and transmit the ACK frame to the STA 906.

[00145] If the STA 906 has negotiated TWTs with the AP 902, the STA 906 may be in active mode at each scheduled TWT and for a certain period after that (e.g., during the TWT service periods associated with the scheduled TWTs), even though the STA 906 has no uplink data to transmit. This may be a burden for the STA 906 that has no more data to transmit to the AP 902. In an aspect, the STA 906 may use a TWT power save mode to conserve power.

[00146] In the TWT power save mode, the STA 906 may be in a doze state and may enter an awake state at the start of the scheduled TWT and may remain in the awake state for the duration of one or more TWT service periods associated with the scheduled TWT. In another aspect, the STA 906 may remain awake for a minimum time duration that is less than the TWT service period. During times outside of the TWT service periods, however, the STA 906 may enter a doze state. In the TWT power save mode, if there are additional TWT service periods associated with the scheduled TWT and the STA 906 has no more data left to transmit (and/or does not expect to receive any data from the AP 902), the STA 906 may want to enter the sleep state for the remaining TWT service periods (e.g., switch to power save mode). For this case, a power save move switch signaling is needed as described below. In one configuration, when the STA 906 is in the TWT power save mode, the STA 906 may additionally continue to satisfy the requirements of the existing PS mode (e.g., enter the awake state to receive selected beacons, to receive group addressed transmissions following certain received beacon frames, to receive transmission during the service period of a scheduled groupcast with retries service period (GCR-SP), to transmit, or to wait for responses to transmitted PS-poll frames or to receive contention free (CF) transmission of data.) In another configuration, the STA 906 may not satisfy the requirements of the PS mode and simply remain in a sleep state.

[00147] Referring to FIG. 9, when the STA 906 determines 912 to switch to a TWT power save mode, the STA 906 may transmit a message 914 (e.g., a frame) to the AP 902 indicating that the STA 906 intends to switch from an active mode to a TWT power save mode or from a PS mode to a TWT power save mode. The message 914 may include an indicator or field (e.g., an end of service period (EOSP) field) that indicates the power management mode that the STA 906 will adopt upon

successful completion of the message/frame exchange. For example, if the field is set to 1 (e.g., EOSP is 1), then the message 914 may indicate that the STA 906 is switching from a TWT power save mode to PS mode. If the field is set to 0, then the message 914 indicates that the STA 906 is not switching from the TWT power save mode to the PS mode. In certain embodiments, any field in a frame exchanged with the AP 902 can signal this new state. In other embodiments, certain frame types may be used to signal the transition to or from the TWT power save mode. In an aspect, the STA 906 may only switch between the active mode and the TWT power save mode, or only between the PS mode and the TWT power save mode. In this aspect, the transition between states may be signaled by a 1-bit power management subfield in the message 914. When the power management subfield has 1 bit, the STA 906 may be able to switch between two modes—active mode and TWT power save mode or TWT power save mode and PS mode. In another aspect, the power management subfield may have 2 bits, which would enable the STA 906 to switch between all three modes. For example "00" could represent the PS mode, "01" could represent the TWT PS mode, and "10" could represent the active mode.

[00148] Upon receiving the message 914, the AP 902 may store the power management mode to which the STA 906 intends switch. For example, if the message 914 indicates that the STA 906 intends to switch to the TWT power save mode, then the AP 902 may store information indicating that the STA 906 is in a TWT power save mode. In this mode, the AP 902 may know not to transmit any data to the STA 906 outside of the TWT service periods in which the STA 906 is awake. Subsequently, the AP 902 may transmit an acknowledgment message 916 to the STA 906 indicating that the AP 902 received the message 914.

[00149] In an aspect, the AP 902 may transmit a second message 918 to the STA 906. The second message 918 may instruct the STA 906 to switch from a TWT power save mode to a PS mode using an EOSP field. For example, the AP 902 may set the EOSP field to 1 to instruct the STA 906 to switch from the TWT power save mode to the PS mode. The AP 902 may also transmit the second message 918 to other STAs 908, 910.

[00150] Once the STA 906 goes into PS mode, however, the AP 902 may not be able to indicate to the STA 906 to switch back to the TWT power save mode by sending a frame that is intended to indicate to the STA 906 to switch modes because the STA 906 may be in a sleep state for an extended period of time. However, the STA 906

may request to switch back to the TWT power save mode by sending a request to switch (e.g., a request similar to the message 914). For example, the STA 906 may transmit another message to the AP 902. The other message may include an EOSP field set to 0 to indicate that the STA 906 requests to switch back to the TWT power save mode. Otherwise, the STA 906 may set the EOSP to 1 to indicate that the STA 906 does not want to switch back to the TWT power save mode. In certain embodiments, the power management subfield may be used for similar signaling. In certain embodiments, the power management switch may be performed by sending a TWT request or an unsolicited TWT response. In certain embodiments, the AP 902 may selectively indicate to certain STAs to switch from PS mode to TWT power save mode by activating a bit in a traffic indication map element that may be included in a message frame (e.g., the second message 918). For example, the second message 918 may be a beacon message, and the second message 918 may include a TIM element that includes a bitmap. The STAs 906, 908, 910 may receive the second message 918 and determine whether to switch to a TWT power save mode based on the each AID position in the bitmap. For example, if a position in the bitmap corresponding to the AID of the STA 906 has a value of 0, then the STA 906 may switch to the TWT power save mode. In certain embodiments, the validity of the new mode is limited to the beacon interval that follows the beacon frame (e.g., the second message 918).

[00151] FIG. 10 is a flowchart of an example method 1000 of switching to or from a TWT power save mode. The method 1000 may be performed using an apparatus (e.g., the STA 906, the AP, 902, or the wireless device 1302, *infra,* for example). Although the method 1000 is described below with respect to the elements of wireless device 1302 of FIG. 13, *infra,* other components may be used to implement one or more of the steps described herein.

[00152] At block 1005, the apparatus may receive an indication from the second wireless device instructing the apparatus to switch to or to switch away from the TWT power save mode. For example, referring to FIG. 9, the apparatus may be the STA 906, and the STA 906 may receive a message from the AP 902 instructing the STA 906 to switch to the TWT power save mode. In an aspect, the message may include an EOSP set to 1, indicating that the TWT service period is ending and no more data will be transmitted.

[00153] At block 1010, the apparatus may determine whether to switch to an active mode, a power save mode, or a TWT power save mode. In the TWT power save mode, the apparatus may enter an awake state during TWT service periods and enter a doze state outside of the TWT service periods. In one configuration, the apparatus may determine whether to switch by determining if there is additional data for transmission or reception by the apparatus. In another configuration, the apparatus may determine whether to switch modes by receiving a QoS message from the second wireless device and by determining whether the QoS message includes an EOSP indicator set to 0 or 1. In another configuration, the apparatus may determine whether to switch modes by receiving a trigger message from the second wireless device and by determining whether the trigger message includes a cascaded indicator set to 0 or 1 and by determining whether the trigger message is intended for the apparatus. For example, referring to FIG. 9, the STA 906 may determine to switch to the TWT power save mode based on the determination that a QoS message is received from the AP 902 indicating an EOSP set to 1.

[00154] At block 1015, the apparatus may transmit a message to a second wireless device based on the determination. For example, referring to FIG. 9, the STA 906 may transmit the message 914 to the AP 902 based on the determination to switch to the TWT power save mode. The message 914 may include a power management field set to 1, indicating that the STA 906 wants to switch to the TWT power save mode.

[00155] At block 1020, the apparatus may determine a mode of the second wireless device. In one configuration, the apparatus may determine the mode by receiving a second message from the second wireless device that includes a responder mode indicator. The apparatus may determine whether the responder mode indicator indicates whether the second wireless device is in the doze state outside of the TWT service periods. If so, then the second wireless device may be in the TWT power save mode; otherwise, the second wireless device may be in the active mode. In another configuration, the apparatus may determine the mode by receiving a trigger message from the second wireless device and by determining whether the trigger message includes resource allocations to any wireless devices. For example, referring to FIG. 9, the STA 906 may receive a message from the AP 902 that includes a responder PM mode indicator (e.g., in a control field). The responder PM

mode indicator may be set to 1, indicating that the AP 902 is in the TWT power save mode.

[00156] At block 1025, the apparatus may receive from the second wireless device a second message that includes a traffic indication map. The traffic indication map may indicate a mode of operation for the first wireless device to select. For example, the STA 906 may receive from the AP 902 message that includes a TIM. The TIM may include a bit associated with the AID of the STA 906. If the bit is set to 1, then the STA 906 may expect to receive data and may enter into a TWT power save mode or an active mode, but if the bit is set to 0, then the STA 906 may not expect to receive data and may enter into a power save mode.

[00157] FIG. 11 is a flowchart of an example method 1100 of signaling for switching to a TWT power save mode. The method 1100 may be performed using an apparatus (e.g., the AP 902, STA 906, or the wireless device 1302, *infra,* for example). Although the method 1100 is described below with respect to the elements of wireless device 1302 of FIG. 13, *infra,* other components may be used to implement one or more of the steps described herein.

[00158] At block 1105, the apparatus may receive a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a TWT power save mode. During the TWT power save mode, the second wireless device may enter an awake state during TWT service periods and enter a doze state outside of the TWT service periods. For example, referring to FIG. 9, the apparatus may be the AP 902. The AP 902 may receive the message 914 from the STA 906 indicating an intention of the STA 906 to switch to a TWT power save mode during which the STA 906 may enter an awake state during TWT service periods and may enter a doze state outside of the TWT service periods.

[00159] At block 1110, the apparatus may store the operating mode associated with the second wireless device. For example, referring to FIG. 9, the AP 902 may store information indicating that the STA 906 is in the TWT power save mode.

[00160] At block 1115, the apparatus may transmit to the second wireless device an acknowledgment of the operating mode switch. For example, referring to FIG. 9, the AP 902 may transmit the acknowledgment message 916 indicating that the AP 902 acknowledges the switch to the TWT power save mode by the STA 906.

[00161] At 1120, the apparatus may transmit a QoS message that includes an EOSP indicator set to 1 to instruct the second wireless device to switch operating modes. For example, referring to FIG. 9, the AP 902 may transmit a QoS frame to the STA 906 with an EOSP indicator set to 1, which instructs the STA 906 to switch operating modes.

[00162] At 1125, the apparatus may transmit a responder mode indicator that indicates whether the first wireless device is in a doze state outside of the TWT service periods. For example, referring to FIG. 9, the AP 902 may transmit a message that includes the responder PM mode indicator in a control field, and the responder PM mode indicator may be set to 1, indicating that the AP 902 is in TWT power save mode.

[00163] At 1130, the apparatus may transmit a trigger message with unassigned resources to indicate that the apparatus will enter into a doze state. For example, referring to FIG. 9, the AP 902 may transmit a trigger frame with unassigned resources to the STAs, which indicates that the AP 902 will enter into a doze state.

[00164] At 1135, the apparatus may transmit a traffic indication map that indicates the operating mode for the second wireless device to select. For example, referring to FIG. 9, the AP 902 may transmit the TIM with a bit set to 1 corresponding to the AID of the STA 906, which indicates that the STA 906 should be in the active mode.

[00165] At 1140, the apparatus may transmit an indication to the second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode. For example, referring to FIG. 9, the AP 902 may transmit the second message 918 instructing the STA 906 to switch to a TWT power save mode from the active mode.

[00166] Additionally, during a TWT service period the AP may transmit one or more trigger frames and/or may not want to always use the full duration of the TWT service period. For example the AP may want to send a trigger frame to poll one or more STAs for feedback (e.g., PS-polls or resource requests), a trigger frame for UL data delivery from the one or more STAs, a trigger frame to exchange DL data with one or more STAs, etc. To allow the STAs determine the number of frames to expect or an early termination of the TWT service period the AP may indicate the number of trigger frames the AP intends to transmit in the TWT element itself. In another embodiment, the AP may indicate that the AP has more trigger frames to

transmit in any frame the AP transmits during the TWT service period. For example, the AP may indicate that the AP intends to transmit at least another trigger frame following the current frame by setting a bit in the frame that is currently transmitting to 1. In one embodiment, the frame may be a trigger frame and the bit may be the More Data field in the Frame Control field, a newly defined field, or the AP may rely on the EOSP field signaling. In another embodiment, the frame can be any other frame sent by the AP. For example, the bit may be the power management field in the frame control field of a frame transmitted by the AP during the TWT service period. In another embodiment, any other field or value can be used for this purpose. For example an EOSP field can be set to 1 to indicate that the AP does not intend to transmit another (trigger) frame during this TWT service period. In another example, the More Data field, or the other fields described above, may be set to 0 to indicate that the AP intends to transmit another (trigger) frame during this TWT service period. Hence, STAs receiving this indication (that there are no more trigger frames during this TWT service period) may go to sleep earlier than the end of the scheduled TWT service period. The STAs that are addressed by the trigger frame may not go to sleep as they are scheduled to transmit UL frames as a response to the trigger frame. The rest of the STAs that went to sleep for the rest of the scheduled TWT service period may wake up in other TWTs (next TWTs) as negotiated or indicated by the AP in previous exchanges or schedules.

[00167] FIG. 12 is an exemplary diagram of a request type field 1200 within a TWT element for broadcast TWT. Referring to FIG. 12, the request type field may contain a TWT flow identifier subfield, which may have various values as indicated in FIG. 12. The TWT flow identifier subfield may contain a 3-bit value that identifies specific information associated with a TWT request uniquely from other requests made between a same TWT requesting STA and a TWT responding STA pair. In broadcast TWT mode, there may not be a concept of a STA pair. As such, the TWT flow identifier subfield may be used to specify different flows (or the traffic class) that may be allowed for the broadcast TWT in a TWT service period.

[00168] Referring to FIG. 12, in one aspect, when the TWT flow ID is set to 0, then there may not be any constraints on the type of frame that can be exchanged during the scheduled TWT service period(s) specified by the TWT parameter set of the broadcast TWT containing the TWT Flow ID. In another aspect, when the TWT flow ID is set to 1, then only frames that contain feedback and/or management

information may be exchanged (e.g., PS-Poll, CQI, buffer status, sounding information, action, etc.). In this aspect, the trigger frame may contain no RUs (e.g., resource units) for random access. In another aspect, when the TWT flow ID is set to 2, then only frames that contain feedback and/or management information may be exchanged (e.g., PS-Poll, CQI, buffer status, sounding information, action, pre-association frames, etc.). In this aspect, the trigger frame may contain at least one RU (or resource unit) for random access. In an aspect, QoS frames may also be exchanged when the TWT flow ID is set to 1 or 2. In yet another aspect, when the TWT flow ID is set to 3, quality of service constrained frames (e.g., short frames with payloads less than 256 or 128 bytes of a particular AC/type, etc.) may be exchanged.

[00169] In another aspect, the TWT flow identifier subfield may indicate that no transmissions are expected from any device (e.g., APs or STAs that may or may not be associated with the device transmitting the frame containing the TWT element). For example, when the TWT flow ID is set to 4 (or some other value), then no transmission are expected (i.e., a black out service period). In addition to helping STAs conserve power, this feature may also be used to cause STAs to enter or remain in a sleep mode in order to reserve a time duration for another device to communicate. This is beneficial also when the device transmitting this TWT element is aware of other devices (not associated to it) that intend to transmit to one or more other devices during a scheduled period of time (knowledge provided in some embodiments by the other devices via similar TWT elements or other means of schedule information exchange mechanisms).

[00170] Although the TWT flow ID values are provided in the TWT flow identifier subfield, similar values for purposes of identifying a flow type for a broadcast TWT may be provided in other fields within a TWT element or other parts of frames transmitted by the device providing the scheduling for one or more other devices.

[00171] FIG. 13 illustrates a method 1300 of broadcasting TWTs for multiple TWTs. Referring to FIG. 13, an AP may indicate a broadcast target trigger (wake) time(s) in an information element (e.g., a TWT element) included in a beacon 1305 or in any other management frame. In one aspect, the TWT pattern provided by the element may be periodic. As an example, in this aspect, a TWT element may contain a TWT field and a TWT wake interval which enables the periodic pattern. In another aspect, the partem may be aperiodic. In this aspect, a TWT element may signal

multiple aperiodic TWTs per beacon interval. This may allow for greater flexibility of target wake times within a beacon interval, DTIM interval, or through the lifetime of the operation.

[00172] To enable multiple aperiodic TWTs per beacon interval, etc, more than one TWT parameter set may be included in a beacon frame or another frame. In one aspect, more than one TWT information element may be included in a beacon. In another aspect, a TWT element may be modified such that the TWT element may carry multiple TWT parameter sets. For example, the TWT element may carry multiple occurrences of the fields following the control field of the element. The TWT parameter set may consist of one or more of the following fields: Request Type, TWT, TWT Grouping, Nominal Minimum Wake Duration, TWT Wake Interval Mantissa, TWT Channel, NDP Paging, etc. The length of the TWT elements may provide signaling to determine its content. As an example, if each TWT parameter set (which length is based on the signaling contained therein) is 7 bytes, then the length field of the TWT element may be equal to 15 bytes (7*2 plus one byte of Control field) if the TWT element contains 2 TWT parameter sets, and so on.

[00173] FIG. 14 illustrates a method 1400 of employing a cascaded field (earlier mentioned as more data, power management, etc.) in a trigger frame within a TWT service period. Referring to FIG. 14, an AP may notify the STAs expected to wake up at the TWT service period via an TWT information element included within a beacon 1405 or frame in general. In an aspect, the AP may overestimate a number of STAs to be allocated in a TWT service period. This is because in broadcast TWT, only a portion of STAs may likely be served (or expected to be awake, or able to successfully receive the frame carrying the TWT) during the TWT service period (this is also possible for solicited TWTs (or negotiated TWTs mentioned earlier)). As such, an AP may send a trigger frame 1410 at the start of a TWT service period. The trigger frame 1410 may contain a list of association identifiers (AIDs) (or other AP assigned identifiers) for STAs to enable uplink transmission. That is, each AID may identify a STA. The trigger frame 1410 may contain a cascaded subfield that indicates whether an additional trigger frame follows the trigger frame 1410 in the TWT service period. For example, if the cascaded subfield is set to 1, then another trigger frame (e.g., a second trigger frame 1415) follows the trigger frame 1410.

However, if the cascaded subfield is set to 0, then no trigger frame will follow the trigger frame 1410 within the same TWT service period.

[00174] A non-AP STA that receives the trigger frame 1410 has several options. The STA may transmit an uplink frame as a response to the trigger frame 1410 that is intended for the STA (e.g., STAs 1, 2, 3, 4). If the cascaded field is set to 1 and the trigger frame 1410 is not intended for the STA, then the STA (e.g., STAs 5, 6, 7) may remain awake to receive the second trigger frame 1415, for example (though STAs may go to sleep for the duration of the UL PPDUs transmitted as a response to the current trigger frame). In another aspect, the STA may enter a sleep mode (or doze state) if the trigger frame 1410 was not intended for the STA and the cascaded field of the trigger frame 1410 was set to 0. After receiving the uplink transmissions from the various STAs, the AP may transmit an acknowledgment (e.g., a multi-block acknowledgment (MBA)). In another aspect, a STA may start contending independently to access the medium after the frame exchange enabled by a trigger frame with a cascaded field equal to 0. In certain embodiments, the STA should not start contending to access the medium after receiving a trigger frame that contains a cascaded field equal to 1.

[00175] FIG. 15 is an exemplary diagram of a TWT group assignment field 1500 within a TWT element for a broadcast TWT for multiple STAs. Referring to FIG. 15, the TWT group ID subfield may have 7 bits (e.g., corresponding to B0 to B6), the zero offset present subfield may have 1 bit (e.g., corresponding to B7), the zero offset of group subfield may have 48 or 0 bits (e.g., corresponding to B8 to B55), the TWT unit subfield may have 4 bits (e.g., corresponding to B56 to B59), and the TWT offset subfield may have 12 bits (e.g., corresponding to B60 to B71). Within the TWT offset subfield, there may be a start AID subfield, an end AID subfield, and a reserved subfield. The start AID subfield may have 5 bits, the end AID subfield may have 5 bits, and the reserve subfield may have 2 bits. Although FIG. 15 depicts start AID and end AID subfields, other IDs assigned by an AP aside from AIDs may also be used.

[00176] The TWT group assignment field may be negotiated and used by an AP to allocate TWTs for STAs within a group. For each STA in the group identified by the TWT group ID, the TWT group assignment subfield may provide information for staggered (offset) TWTs within the group itself. In an aspect, the TWT group assignment subfield may be used when the AP wants to stagger UL single user

transmissions from multiple STAs of a group. In another aspect, the TWT group assignment subfield may be used to specify the group of STAs to wake up at a TWT. For example, the TWT group assignment field may identify the range of STAs that are scheduled to wake up at the specified TWT.

[00177] In an aspect, when the trigger field within the request type field is set to 1, the TWT group ID may specify the 7 most significant bits of the AID (or another AP assigned ID) of each of the STAs that belong to the group that is to wake up at a certain TWT. The TWT unit may be reserved, for example, to indicate an offset of uplink transmissions from the first TWT is not needed since uplink transmissions may be trigger after an XIFS, in which the XIFS may be a short interframe space (SIFS) or a point coordination function (PCF) interframe space (PIFS)). The TWT offset field may contain the 5 least significant bits of the start AID and the 5 least significant bits of the end AID of the group.

[00178] In another aspect, when the zero offset present is set to 1, the zero offset of group field may specify the TWT if the TWT wake time field is not present. In another aspect, for the basic broadcast TWT case, the TIM element may also provide a list of STAs to be polled by triggers. In an aspect, a broadcast TWT that supports multiple STAs may improve signaling for purposes of identifying a group of STAs for multi-user operation in a TWT element.

[00179] FIG. 16 illustrates an exemplary diagram of a second TWT element format 1600. Referring to FIG. 16, a TWT element 1605 may include an element ID field (e.g., 1 octet in length), a length field (e.g., 1 octet in length), a control field (e.g., 1 octet in length), a request type field (e.g., 2 octets in length), a target wake time field (e.g., 2, 4, 6, or 8 octets in length), a TWT group assignment field (optional), a nominal minimum wake duration field (e.g., 1 octet in length), a TWT wake interval mantissa field (e.g., 2 octet in length), a TWT channel (optional), and/or an NDP paging field (optional as well). The one or more of the request type field, target wake time field, TWT group assignment field, nominal minimum wake duration field, TWT wake interval mantissa field, and/or TWT channel field may make up a TWT set or equivalently TWT parameter set. The TWT element 1605 may have one or more TWT parameter sets, which may be used to indicate different TWT service period(s).

[00180] The control field may have multiple subfields, such as a NDP paging indicator subfield (e.g., 1 bit), a broadcast subfield (e.g., 1 bit), a responder PM (passive

mode) mode subfield (e.g., 1 bit), and/or a reserved subfield (e.g., 5 bits). The broadcast bit may be used to indicate whether the TWT element 1605 is a broadcast TWT, in which target wake times may not be negotiated between an AP and a STA, or whether the TWT element 1605 is a solicited TWT, in which target wake times may be negotiated between an AP and a STA or between a STA and another STA. For example, when the broadcast bit is set to 1, then the TWT element 1605 may be a broadcast TWT, and when the broadcast bit is set to 0, then the TWT element 1605 may be a solicited TWT. The broadcast bit may also be referred to as a non-negotiable indication. In one configuration, the responder PM mode subfield may indicate that a TWT responder may be in a doze state outside of the TWT SPs (e.g., for a broadcast TWT, the TWT responder may be the AP). In one option, the AP may set the responder PM mode subfield to 1 to indicate that the AP may be in a doze state outside of the TWT SPs. Alternatively, the AP may set the responder PM mode subfield to 0 if the AP is not allowed to enter into a power save mode. In another configuration, the AP may indicate that the AP is in power save mode by transmitting one or more trigger frames, which may include resource allocations (e.g., resource units) not allocated to any STAs during a TWT service period during which the AP intends to enter power save mode.

[00181] The length field may indicate the length of the TWT element 1605 and may be used to determine the number of TWT parameter sets within the TWT element 1605. For example, if the length field indicates that the TWT element 1605 is 8 bytes, then the TWT element 1605 may have one TWT parameter set (e.g., 7 bytes of fields for the one set and one byte of Control field). If the length field indicates 15 bytes, then the TWT element 1605 may have two TWT parameter sets. As such, the length field may indicate the number of TWT sets.

[00182] The request type field may have one or more of the following subfields, such as a repetition subfield, a trigger subfield, a reserved subfield, a flow type subfield, a TWT flow identifier subfield, a wake interval exponent subfield, and/or a TWT protection subfield. In an aspect, the request type field may be 1 byte in length and include a repetition subfield (e.g., 2 bits), a trigger subfield (e.g., 1 bit), a TWT flow identifier subfield (e.g., 3 bits), and a wake interval exponent (e.g., 2 bits). In another aspect, the request type field may not include the wake interval exponent subfield, whose value may be preconfigured within a device (e.g., a device may have a preconfigured value of 10 with respect to the wake interval exponent field).

If the TWT is periodic (e.g., the TWT set may contain a non-zero value of the TWT wake interval mantissa field), then the repetition subfield may indicate the number of valid TWT service periods associated with the TWT minus 1 specified by the TWT parameter set. The "minus 1" accounts for the TWT indicated in the target wake time field. For example, if the TWT is valid for 6 TWT service periods, then the repetition field may be set to 5. In an aspect, if the TWT wake interval mantissa subfield is set to 0, then the TWT is not periodic. By contrast, if the TWT interval mantissa subfield has a non-zero value, then the TWT may be periodic and may repeat for as many times as specified by the value indicated in the repetition subfield. The TWT Wake Interval may be determined based on a product of the TWT wake interval mantissa and 2 elevated to the power of the value indicated in the wake interval exponent *(period = TWT Wake Interval Mantissa* x 2***wake interval Exponent^*** In another aspect, a repetition subfield set to 0 may indicate an aperiodic TWT.

[00183] The trigger subfield indicates whether a trigger (e.g., a trigger frame) will be sent at the start of a target wake time(s) specified by the TWT set. In such embodiment this field may be set to 1. Otherwise it may be set to 0 to indicate that there will be no trigger frame sent at the start of the target wake time(s). The TWT flow identifier subfield indicates the type of data flow expected during the TWT service period(s) specified by the TWT set. The TWT flow identifier subfield may be associated with values indicated in FIG. 12. The target wake time subfield may include the 2 least significant bytes of the value that the TSF timer (as contained in the timestamp field of a beacon frame transmitted in that instant of time) will have at the first (if periodic) or only TWT (if aperiodic). In another aspect, the target wake time subfield may include a shifted subset of the 2 least significant bytes of the TSF timer. For example, assuming the TSF timer has 8 bytes, instead of including the least significant 2 bytes, the subset may be shifted in which the TWT field includes the second and third least significant bytes of the 8 byte representation of the TSF timer, in which case the time resolution may not be of say 1 microsecond, but rather 256 microseconds. By doing so the 2 byte TWT field may indicate larger time values (while losing some resolution). In certain embodiments, the bit shifting may occur at the bit level rather than the byte level.

[00184] The TWT protection subfield may indicate that the TWT service period(s) specified by a corresponding TWT parameter set may be protected or not (or asked

to be protected or not in a TWT request). In one aspect, when the TWT protection subfield is set to 0, then the TWT service period(s) may not be protected. In another aspect, when the TWT protection subfield is set to 1, the subfield may indicate that STAs associated with the AP sending the TWT element 1605 and that have read the frame carrying the TWT element 1605 should not contend to access the medium for the specified duration of the TWT service period(s) indicated in the corresponding TWT set. In another embodiment, only STAs that have traffic that is allowed by the AP to be delivered during the TWT service period(s) may contend to access the medium. For example, when the AP sends a TWT element that indicates that there is no trigger frame at the start of the TWT, and the TWT is an announced TWT (e.g., STAs should send a frame to the AP), then only the STAs that may have certain type of traffic (e.g., PS-Polls or U-APSD trigger frames) may access the medium to transmit their frames. In another aspect, when the TWT protection subfield is set to 1, the subfield may indicate that STAs that are not associated with the AP and that have read the frame carrying the TWT element 1605 should not contend to access the medium for the specified durations of the TWT service period(s). The AP that set the TWT protection subfield to 1 may also indicate that the AP intends to transmit NAV setting frames at the start of the TWT service period(s) to protect at least a part of the duration of the TWT service period(s). If the TWT element 1605 contains a list of STAs for which the TWT element 1605 is intended, the intended STA recipients of the TWT element 1605 may discard the NAV setting frame sent by the AP at the start of the TWT service period(s) and access the medium, or transmit to any frame that is sent by the AP immediately (e.g., in SIFS time). In another aspect, the AP that set the TWT protection subfield to 1 may indicate that scheduled data exchanges during the TWT SP may be preceded by a multi-user (MU) request to send (RTS) and clear to send (CTS) message exchange.

[00185] In an aspect, another AP that has set up another BSS and is within range of the AP that sent the TWT element 1605 (e.g., is able to read the frame carrying the TWT element 1605) may not allocate resources to any of the STAs associated with the another AP during the TWT service period(s) so as to minimize the risk of inter-BSS collisions.

[00186] In the foregoing description, unless expressly indicated, methods, functions, protocols, and techniques described with respect to a STA may also be applicable to an AP, and vice versa.

[00187] FIG. 17 shows an example functional block diagram of a wireless device 1702 that may perform TWT scheduling within the wireless communication system 100 of FIG. 1. The wireless device 1702 is an example of a device that may be configured to implement the various methods described herein. For example, the wireless device 1702 may comprise one of the APs 104, 302, 602, 902 or one of the STAs 112, 114, 116, 118, 306, 308, 310, 606, 608, 610, 906, 908, 910.

[00188] The wireless device 1702 may include a processor 1704 which controls operation of the wireless device 1702. The processor 1704 may also be referred to as a central processing unit (CPU). Memory 1706, which may include both read-only memory (ROM) and random access memory (RAM), may provide instructions and data to the processor 1704. A portion of the memory 1706 may also include non-volatile random access memory (NVRAM). The processor 1704 typically performs logical and arithmetic operations based on program instructions stored within the memory 1706. The instructions in the memory 1706 may be executable (by the processor 1704, for example) to implement the methods described herein.

[00189] The processor 1704 may comprise or be a component of a processing system implemented with one or more processors. The one or more processors may be implemented with any combination of general-purpose microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate array (FPGAs), programmable logic devices (PLDs), controllers, state machines, gated logic, discrete hardware components, dedicated hardware finite state machines, or any other suitable entities that can perform calculations or other manipulations of information.

[00190] The processing system may also include machine-readable media for storing software. Software shall be construed broadly to mean any type of instructions, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. Instructions may include code (e.g., in source code format, binary code format, executable code format, or any other suitable format of code). The instructions, when executed by the one or more processors, cause the processing system to perform the various functions described herein.

[00191] The wireless device 1702 may also include a housing 1708, and the wireless device 1702 may include a transmitter 1710 and/or a receiver 1712 to allow transmission and reception of data between the wireless device 1702 and a remote device. The transmitter 1710 and the receiver 1712 may be combined into a

transceiver 1714. An antenna 1716 may be attached to the housing 1708 and electrically coupled to the transceiver 1714. The wireless device 1702 may also include multiple transmitters, multiple receivers, multiple transceivers, and/or multiple antennas.

[00192] The wireless device 1702 may also include a signal detector 1718 that may be used to detect and quantify the level of signals received by the transceiver 1714 or the receiver 1712. The signal detector 1718 may detect such signals as total energy, energy per subcarrier per symbol, power spectral density, and other signals. The wireless device 1702 may also include a digital signal processor (DSP) 1720 for use in processing signals. The DSP 1720 may be configured to generate a packet for transmission. In some aspects, the packet may comprise a PPDU.

[00193] The wireless device 1702 may further comprise a user interface 1722 in some aspects. The user interface 1722 may comprise a keypad, a microphone, a speaker, and/or a display. The user interface 1722 may include any element or component that conveys information to a user of the wireless device 1702 and/or receives input from the user.

[00194] When the wireless device 1702 is implemented as a STA (e.g., the STAs 306, 606, 906) or as an AP (e.g., the APs 302, 602, 902), the wireless device 1702 may also comprise aTWT component 1724.

[00195] In one configuration, the wireless device 1702 may be a TWT requester for solicit TWTs. In this configuration, the TWT component 1724 may be configured to transmit a first message that includes a first trigger field to a second wireless device (e.g., a TWT responder). The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the second wireless device at a start of a TWT service period. The TWT component 1724 may be configured to receive a second message from the second wireless device. The second message may include a second trigger field based on the first message. The second trigger field may indicate whether the second wireless device will transmit the trigger message at the start of the TWT service period. In an aspect, the first message may include a requested TWT, the first trigger field may be set to 1, and the first message may request the trigger message to be sent at the requested TWT. In another aspect, the second message may include a scheduled TWT, the second trigger field may be set to 1, and the second message may indicate that the second wireless device may transmit the trigger message at the scheduled TWT. In another

aspect, the scheduled TWT may be different from a requested TWT included in the first message. In one embodiment, the TWT component 1724 may be configured to determine a TWT schedule based on the received second message and to determine whether to transmit to the second wireless device based on the determined TWT schedule. In this embodiment, the TWT component 1724 may be configured to determine the TWT schedule by determining whether the TWT schedule is an implicit TWT schedule or an explicit TWT schedule based on the received second message and by determining one or more TWTs associated with the TWT schedule based on the received second message. In another embodiment, the TWT component 1724 may be configured to determine whether to transmit by determining to transmit during the TWT service period when a trigger message is received from the second wireless device or by determining to transmit outside of the TWT service period based on EDCA parameters associated with AC_BE or AC_BK. In another aspect, the TWT component 1724 may determine to transmit during the TWT service period based on the received trigger message, and the transmission may not based on EDCA contention. In another embodiment, the TWT component 1724 may be configured to receive a trigger message based on the determined TWT schedule. The trigger message may include a cascaded indicator that indicates whether the second wireless device will transmit another trigger message after the trigger message in the TWT service period. In another embodiment, the TWT component 1724 may be configured to receive a TWT information message from the second wireless device, and the TWT information message may include a next TWT value. The TWT component 1724 may be configured to update the TWT schedule based on the received TWT information message. In another embodiment, the TWT schedule may be the implicit TWT schedule, and the TWT component 1724 may be configured to transmit a TWT information message to the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another aspect, the first message may include a TWT channel indicator that indicates a channel and a channel width that the TWT component 1724 may use for communicating with the second wireless device during the TWT service period. In another aspect, the first message may include an OFDMA bitmap that indicates one

or more OFDMA channels and channel widths to be used for communicating with the second wireless device.

[00196] In another configuration, the wireless device 1702 may be a TWT responder for solicit TWTs. In this configuration, the TWT component 1724 may be configured to receive, from a second wireless device, a first message that includes a first trigger field. The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the wireless device 1702 at a start of a TWT service period. The TWT component 1724 may be configured to determine a TWT schedule based on the received first message. The TWT component 1724 may be configured to transmit a second message to the second wireless device. The second message may include the TWT schedule and a second trigger field based on the determined TWT schedule. The second trigger field may indicate whether the wireless device 1702 may transmit the trigger message at the start of the TWT service period. In an aspect, the first message may include a requested TWT, the first trigger field may be set to 1, and the first message may request the trigger message to be sent at the requested TWT. In another aspect, the second message may include a scheduled TWT, the second trigger field may be set to 1, and the second message may indicate that the wireless device 1702 will transmit the trigger message at the scheduled TWT. In another aspect, the scheduled TWT may be different from a requested TWT included in the first message. In an embodiment, the TWT component 1724 may be configured to determine the TWT schedule by determining if the first trigger field includes the request for the trigger message and by scheduling one or more TWTs for the second wireless device if the first trigger field includes the request for the trigger message. In another embodiment, the TWT component 1724 may be configured to transmit a TWT information message that includes a next TWT value that is different from all TWT values associated with the TWT schedule included in the second message. In another embodiment, the TWT schedule may be an implicit TWT schedule, and the TWT component 1724 may be configured to receive a TWT information message from the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another aspect, the second message may include a TWT channel indicator that indicates a channel and a channel width to be used for communicating between the wireless device 1702 and the second wireless device

during the TWT service period. In another embodiment, the TWT component 1724 may be configured to transmit a trigger message that includes a cascaded indicator. The cascaded indicator may indicate whether the wireless device 1702 will transmit another trigger message after the trigger message in the TWT service period. In another aspect, the second message may include a TWT protection indicator that indicates whether message exchanged with the wireless device 1702 based on the TWT schedule are to be preceded by an RTS and a CTS message exchange.

[00197] In another configuration, the wireless device 1702 may broadcast TWTs to other wireless devices. In this configuration, the TWT component 1724 may be configured to determine a TWT schedule and to broadcasting a message that includes the TWT schedule to other wireless devices. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. In an aspect, the broadcast TWT schedule may include non-negotiable TWT parameters for communicating between the wireless device 1702 and at least one wireless device of the wireless devices. In another aspect, the message may further include a trigger field that indicates whether the wireless device 1702 will transmit a trigger message at a start of a TWT service period. In another aspect, the message may include a TWT flow identifier field that indicates a type of data flow allowed during a TWT service period. In another aspect, the type of data flow allowed may include MU OFDMA random access for wireless devices unassociated with the wireless device 1702, MU OFDMA random access for wireless devices associated with the wireless device 1702, MU DL OFDMA scheduled access for wireless devices indicated in a TIM, MU UL OFDMA scheduled access for wireless devices indicated in the TIM, MU UL MIMO scheduled access for wireless devices indicated in the TIM, MU DL MIMO scheduled access for wireless devices indicated in the TIM. In another aspect, the TWT flow identifier field may indicates one of the following types of allowed data flows: no constraints on a type of message to be exchanged with the wireless device 1702, messages containing feedback information or management information can be exchanged with the wireless device 1702 and trigger messages from the wireless device 1702 do not include resource units for random access, messages containing feedback information or management information can be exchanged with the wireless device 1702 and trigger messages from the wireless device 1702 include resource units for random access, messages containing quality of service information can be exchanged with

the wireless device 1702, or no traffic is expected to be communicated to or from the wireless device 1702. In another aspect, the TWT schedule may be an implicit TWT schedule or an explicit TWT schedule. In another aspect, the TWT schedule may be an explicit TWT schedule, the TWT schedule may includes one or more TWT parameter sets, and each TWT parameter set may correspond to a scheduled TWT. In another embodiment, the TWT schedule may be an implicit TWT schedule, and the TWT component 1724 may be configured to transmit a TWT information message to the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another embodiment, the TWT component 1724 may be configured to transmit a TWT information message to the second wireless device, and the TWT information message may indicate a different scheduled TWT than in the TWT schedule in the broadcasted message. In another embodiment, the TWT component 1724 may be configured to transmit a trigger message based on the TWT schedule. The trigger message may include a cascaded indicator that indicates whether the wireless device 1702 will transmit additional trigger messages in the TWT service period. In another aspect, the message may include a TWT group assignment field, and the TWT group assignment field may include a range of identifiers that identifies a group of wireless devices scheduled to wake up at a TWT during a TWT service period. In another aspect, the message may include a repetition indicator, and the repetition indicator may indicate a number of TWT service periods for which a scheduled TWT indicated in the message are valid. In another aspect, the message may include a TWT protection indicator that indicates whether messages exchanged with the wireless device 1702 based on the TWT schedule are to be preceded by an RTS and a CTS message exchange.

[00198] In another configuration, the wireless device 1702 may receive broadcast TWTs and determine whether to join the broadcast TWT. In this configuration, the TWT component 1724 may be configured to receive from a second wireless device a message that includes a TWT schedule. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. The TWT component 1724 may be configured to determine one or more TWTs for the wireless device 1702 based on the TWT schedule. In an aspect, the broadcast TWT schedule may include non-negotiable TWT parameters for communicating between

the wireless device 1702 and the second wireless device. In another aspect, the message may include a trigger field that indicates whether the second wireless device will transmit a trigger message at a start of a TWT service period. In another aspect, the message may include a TWT flow identifier field that indicates a type of data flow allowed during a TWT service period. In another aspect, the TWT flow identifier field may indicate one of the following: no constraints on a type of message to be exchanged with the second wireless device, messages containing feedback information or management information can be exchanged with the second wireless device and trigger messages from the second wireless device do not include resource units for random access, messages containing feedback information or management information can be exchanged with the second wireless device and trigger messages from the second wireless device include resource units for random access, messages containing quality of service information can be exchanged with the second wireless device, or no traffic is expected to be communicated to or from the second wireless device. In another aspect, the TWT schedule may be an implicit TWT schedule or an explicit TWT schedule. In another aspect, the TWT schedule may be an explicit TWT schedule, the TWT schedule may include one or more TWT parameter sets, and each TWT parameter set may correspond to a scheduled TWT. In another aspect, the TWT schedule may be an implicit TWT schedule, and the TWT component 1724 may be configured to receive a TWT information message from the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another embodiment, the TWT component 1724 may be configured to receive a TWT information message from the second wireless device. The TWT information message may indicate a different scheduled TWT than in the received message. In another aspect, the message may include a repetition indicator, and the repetition indicator may indicate a number of TWT service periods for which a scheduled TWT indicated in the message are valid. In another embodiment, the TWT component 1724 may be configured to receive a trigger message based on the determined one or more TWTs. In another aspect, the trigger message may include a cascaded indicator that indicates whether the second wireless device will transmit additional trigger messages after the trigger message in a TWT service period. In another embodiment, the TWT component 1724 may be configured to determine to

transmit to the second wireless device during a TWT service period when the trigger message is received from the second wireless device and to determine to transmit to the second wireless device outside of the TWT service period based on EDCA parameters associated with an AC_BE or an AC_BK.

[00199] In another configuration, the wireless device 1702 may be a TWT requester determining whether to switch operating modes. In this configuration, the TWT component 1724 may be configured to determine whether to switch to an active mode, a power save mode, or a TWT power save mode. During the TWT power save mode, the wireless device 1702 may enter an awake state during TWT service periods and may enter a doze state outside of the TWT service periods. The TWT component 1724 may be configured to transmit a message to a second wireless device based on the determination. In another aspect, the TWT service periods may be identified based on a TWT schedule associated with the wireless device 1702. In another aspect, the message may include a power management indicator that indicates a mode to which the wireless device 1702 intends switch. In another embodiment, the TWT component 1724 may be configured to receive an indication from the second wireless device instructing the wireless device 1702 to switch to or to switch away from the TWT power save mode. In another aspect, the indication may include an EOSP indicator set to 1. In another embodiment, the TWT component 1724 may be configured to determine whether to switch by determining if there is additional data for transmission or reception, by receiving from the second wireless device a QoS message with an EOSP indicator set to 1, or by receiving from the second wireless device a trigger message with a cascaded indicator set to 0 in which the trigger message is not intended for the wireless device 1702. In another embodiment, the TWT component 1724 may be configured to determine a mode of the second wireless device. In another embodiment, the TWT component 1724 may be configured to determine the mode of the second wireless device by receiving a second message from the second wireless device, in which second message may include a responder mode indicator that indicates whether the second wireless device is in a doze state outside of the TWT service periods. The determination of the mode of the second wireless device may be based on the responder mode indicator. In another embodiment, the TWT component 1724 may be configured to determine the mode of the second wireless device by receiving a trigger message from the second wireless device. The determination of the mode of

the second wireless device may be based on whether the trigger message includes resource allocations to any wireless devices. In another embodiment, the TWT component 1724 may be configured to receive from the second wireless device a second message that includes a traffic indication map, and the traffic indication map may indicate a mode of operation for the wireless device 1702 to select.

[00200] In another configuration, the wireless device 1702 may be a TWT responder with respect to operating modes. In this configuration, the TWT component 1724 may be configured to receive a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a TWT power save mode. During the TWT power save mode, the second wireless device may enter an awake state during TWT service periods and may enter a doze state outside of the TWT service periods. The TWT component 1724 may be configured to store the operating mode associated with the second wireless device and to transmit to the second wireless device an acknowledgment of the operating mode switch. In an aspect, the TWT service periods may be identified based on a TWT schedule associated with the second wireless device. In another aspect, the message may include a power management indicator that indicates the operating mode to which the second wireless device intends to switch. In another embodiment, the TWT component 1724 may be configured to transmit a QoS message that may include an EOSP indicator set to 1 to instruct the second wireless device to switch operating modes. In another embodiment, the TWT component 1724 may be configured to transmit a responder mode indicator that indicates whether the wireless device 1702 is in a doze state outside of the TWT service periods. In another embodiment, the TWT component 1724 may be configured to transmit a trigger message with unassigned resources to indicate that the wireless device 1702 will enter into a doze state. In another embodiment, the TWT component 1724 may be configured to transmit a traffic indication map that indicates the operating mode for the second wireless device to select. In another embodiment, the TWT component 1724 may be configured to transmit an indication to the second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode.

[00201] The various components of the wireless device 1702 may be coupled together by a bus system 1726. The bus system 1726 may include a data bus, for example, as

well as a power bus, a control signal bus, and a status signal bus in addition to the data bus. Components of the wireless device 1702 may be coupled together or accept or provide inputs to each other using some other mechanism.

[00202] Although a number of separate components are illustrated in FIG. 17, one or more of the components may be combined or commonly implemented. For example, the processor 1704 may be used to implement not only the functionality described above with respect to the processor 1704, but also to implement the functionality described above with respect to the signal detector 1718, the DSP 1720, the user interface 1722, and/or the TWT component 1724. Further, each of the components illustrated in FIG. 17 may be implemented using a plurality of separate elements.

[00203] FIG. 18 is a functional block diagram of an example wireless communication device 1800 that performs TWT scheduling. The wireless communication device 1800 may include a receiver 1805, a processing system 1810, and a transmitter 1815. The processing system 1810 may include a TWT component 1824 and a mode component 1826.

[00204] In one configuration, the wireless communication device 1800 may be a TWT requester for solicit TWTs. In this configuration, the processing system 1810, the TWT component 1824, and/or the transmitter 1815 may be configured to transmit a first message that includes a first trigger field to a second wireless device (e.g., a TWT responder). The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the second wireless device at a start of a TWT service period. The processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive a second message from the second wireless device. The second message may include a second trigger field based on the first message. The second trigger field may indicate whether the second wireless device will transmit the trigger message at the start of the TWT service period. In an aspect, the first message may include a requested TWT, the first trigger field may be set to 1, and the first message may request the trigger message to be sent at the requested TWT. In another aspect, the second message may include a scheduled TWT, the second trigger field may be set to 1, and the second message may indicate that the second wireless device may transmit the trigger message at the scheduled TWT. In another aspect, the scheduled TWT may be different from a requested TWT included in the first message. In one

embodiment, the processing system 1810 and/or the TWT component 1824 may be configured to determine a TWT schedule based on the received second message and to determine whether to transmit to the second wireless device based on the determined TWT schedule. In this embodiment, the processing system 1810 and/or the TWT component 1824 may be configured to determine the TWT schedule by determining whether the TWT schedule is an implicit TWT schedule or an explicit TWT schedule based on the received second message and by determining one or more TWTs associated with the TWT schedule based on the received second message. In another embodiment, the processing system 1810 and/or the TWT component 1824 may be configured to determine whether to transmit by determining to transmit during the TWT service period when a trigger message is received from the second wireless device or by determining to transmit outside of the TWT service period based on EDCA parameters associated with AC_BE or AC_BK. In another aspect, the processing system 1810 and/or the TWT component 1824 may determine to transmit during the TWT service period based on the received trigger message, and the transmission may not based on EDCA contention. In another embodiment, the processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive a trigger message based on the determined TWT schedule. The trigger message may include a cascaded indicator that indicates whether the second wireless device will transmit another trigger message after the trigger message in the TWT service period. In another embodiment, the processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive a TWT information message from the second wireless device, and the TWT information message may include a next TWT value. The processing system 1810 and/or The TWT component 1824 may be configured to update the TWT schedule based on the received TWT information message. In another embodiment, the TWT schedule may be the implicit TWT schedule, and the processing system 1810, the TWT component 1824, and/or the transmitter 1815 may be configured to transmit a TWT information message to the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another aspect, the first message may include a TWT channel indicator that indicates a channel and a channel width that the TWT component 1824 may use for communicating with the second wireless

device during the TWT service period. In another aspect, the first message may include an OFDMA bitmap that indicates one or more OFDMA channels and channel widths to be used for communicating with the second wireless device.

[00205] In another configuration, the wireless communication device 1800 may be a TWT responder for solicit TWTs. In this configuration, the processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive, from a second wireless device, a first message that includes a first trigger field. The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the wireless communication device 1800 at a start of a TWT service period. The processing system 1810 and/or The TWT component 1824 may be configured to determine a TWT schedule based on the received first message. The TWT component 1824, the processing system 1810, and/or the transmitter 1815 may be configured to transmit a second message to the second wireless device. The second message may include the TWT schedule and a second trigger field based on the determined TWT schedule. The second trigger field may indicate whether the wireless communication device 1800 may transmit the trigger message at the start of the TWT service period. In an aspect, the first message may include a requested TWT, the first trigger field may be set to 1, and the first message may request the trigger message to be sent at the requested TWT. In another aspect, the second message may include a scheduled TWT, the second trigger field may be set to 1, and the second message may indicate that the wireless communication device 1800 will transmit the trigger message at the scheduled TWT. In another aspect, the scheduled TWT may be different from a requested TWT included in the first message. In an embodiment, the processing system 1810 and/or the TWT component 1824 may be configured to determine the TWT schedule by determining if the first trigger field includes the request for the trigger message and by scheduling one or more TWTs for the second wireless device if the first trigger field includes the request for the trigger message. In another embodiment, the processing system 1810, the TWT component 1824, and/or the transmitter 1815 may be configured to transmit a TWT information message that includes a next TWT value that is different from all TWT values associated with the TWT schedule included in the second message. In another embodiment, the TWT schedule may be an implicit TWT schedule, and the processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive a

TWT information message from the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another aspect, the second message may include a TWT channel indicator that indicates a channel and a channel width to be used for communicating between the wireless communication device 1800 and the second wireless device during the TWT service period. In another embodiment, the processing system 1810, the TWT component 1824, and/or the transmitter 1815 may be configured to transmit a trigger message that includes a cascaded indicator. The cascaded indicator may indicate whether the wireless communication device 1800 will transmit another trigger message after the trigger message in the TWT service period. In another aspect, the second message may include a TWT protection indicator that indicates whether message exchanged with the wireless communication device 1800 based on the TWT schedule are to be preceded by an RTS and a CTS message exchange.

[00206] In another configuration, the wireless communication device 1800 may broadcast TWTs to other wireless devices. In this configuration, the processing system 1810 and/or the TWT component 1824 may be configured to determine a TWT schedule and to broadcast a message that includes the TWT schedule to other wireless devices. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. In an aspect, the broadcast TWT schedule may include non-negotiable TWT parameters for communicating between the wireless communication device 1800 and at least one wireless device of the wireless devices. In another aspect, the message may further include a trigger field that indicates whether the wireless communication device 1800 will transmit a trigger message at a start of a TWT service period. In another aspect, the message may include a TWT flow identifier field that indicates a type of data flow allowed during a TWT service period. In another aspect, the type of data flow allowed may include MU OFDMA random access for wireless devices unassociated with the wireless communication device 1800, MU OFDMA random access for wireless devices associated with the wireless communication device 1800, MU DL OFDMA scheduled access for wireless devices indicated in a TIM, MU UL OFDMA scheduled access for wireless devices indicated in the TIM, MU UL MIMO scheduled access for wireless devices indicated in the TIM, MU DL MIMO scheduled access for wireless devices indicated in the TIM. In another aspect, the

TWT flow identifier field may indicates one of the following types of allowed data flows: no constraints on a type of message to be exchanged with the wireless communication device 1800, messages containing feedback information or management information can be exchanged with the wireless communication device 1800 and trigger messages from the wireless communication device 1800 do not include resource units for random access, messages containing feedback information or management information can be exchanged with the wireless communication device 1800 and trigger messages from the wireless communication device 1800 include resource units for random access, messages containing quality of service information can be exchanged with the wireless communication device 1800, or no traffic is expected to be communicated to or from the wireless communication device 1800. In another aspect, the TWT schedule may be an implicit TWT schedule or an explicit TWT schedule. In another aspect, the TWT schedule may be an explicit TWT schedule, the TWT schedule may includes one or more TWT parameter sets, and each TWT parameter set may correspond to a scheduled TWT. In another embodiment, the TWT schedule may be an implicit TWT schedule, and the processing system 1810, the TWT component 1824, and/or the transmitter 1815 may be configured to transmit a TWT information message to the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another embodiment, the processing system 1810, the TWT component 1824, and/or the transmitter 1815 may be configured to transmit a TWT information message to the second wireless device, and the TWT information message may indicate a different scheduled TWT than in the TWT schedule in the broadcasted message. In another embodiment, the processing system 1810, the TWT component 1824, and/or the transmitter 1815 may be configured to transmit a trigger message based on the TWT schedule. The trigger message may include a cascaded indicator that indicates whether the wireless communication device 1800 will transmit additional trigger messages in the TWT service period. In another aspect, the message may include a TWT group assignment field, and the TWT group assignment field may include a range of identifiers that identifies a group of wireless devices scheduled to wake up at a TWT during a TWT service period. In another aspect, the message may include a repetition indicator, and the repetition indicator may indicate a number of TWT

service periods for which a scheduled TWT indicated in the message are valid. In another aspect, the message may include a TWT protection indicator that indicates whether messages exchanged with the wireless communication device 1800 based on the TWT schedule are to be preceded by an RTS and a CTS message exchange.

[00207] In another configuration, the wireless communication device 1800 may receive broadcast TWTs and determine whether to join the broadcast TWT. In this configuration, the processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive from a second wireless device a message that includes a TWT schedule. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. The processing system 1810 and/or the TWT component 1824 may be configured to determine one or more TWTs for the wireless communication device 1800 based on the TWT schedule. In an aspect, the broadcast TWT schedule may include non-negotiable TWT parameters for communicating between the wireless communication device 1800 and the second wireless device. In another aspect, the message may include a trigger field that indicates whether the second wireless device will transmit a trigger message at a start of a TWT service period. In another aspect, the message may include a TWT flow identifier field that indicates a type of data flow allowed during a TWT service period. In another aspect, the TWT flow identifier field may indicate one of the following: no constraints on a type of message to be exchanged with the second wireless device, messages containing feedback information or management information can be exchanged with the second wireless device and trigger messages from the second wireless device do not include resource units for random access, messages containing feedback information or management information can be exchanged with the second wireless device and trigger messages from the second wireless device include resource units for random access, messages containing quality of service information can be exchanged with the second wireless device, or no traffic is expected to be communicated to or from the second wireless device. In another aspect, the TWT schedule may be an implicit TWT schedule or an explicit TWT schedule. In another aspect, the TWT schedule may be an explicit TWT schedule, the TWT schedule may include one or more TWT parameter sets, and each TWT parameter set may correspond to a scheduled TWT. In another aspect, the TWT schedule may be an implicit TWT schedule, and the processing system 1810, the TWT component 1824, and/or the receiver 1805

may be configured to receive a TWT information message from the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another embodiment, the processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive a TWT information message from the second wireless device. The TWT information message may indicate a different scheduled TWT than in the received message. In another aspect, the message may include a repetition indicator, and the repetition indicator may indicate a number of TWT service periods for which a scheduled TWT indicated in the message are valid. In another embodiment, the processing system 1810, the TWT component 1824, and/or the receiver 1805 may be configured to receive a trigger message based on the determined one or more TWTs. In another aspect, the trigger message may include a cascaded indicator that indicates whether the second wireless device will transmit additional trigger messages after the trigger message in a TWT service period. In another embodiment, the processing system 1810 and/or the TWT component 1824 may be configured to determine to transmit to the second wireless device during a TWT service period when the trigger message is received from the second wireless device and to determine to transmit to the second wireless device outside of the TWT service period based on EDCA parameters associated with an AC_BE or an AC_BK.

[00208] In another configuration, the wireless communication device 1800 may be a TWT requester determining whether to switch operating modes. In this configuration, the processing system 1810, the mode component 1826, and/or the TWT component 1824 may be configured to determine whether to switch to an active mode, a power save mode, or a TWT power save mode. During the TWT power save mode, the wireless communication device 1800 may enter an awake state during TWT service periods and may enter a doze state outside of the TWT service periods. The processing system 1810, the TWT component 1824, the mode component 1826, and/or the transmitter 1815 may be configured to transmit a message to a second wireless device based on the determination. In another aspect, the TWT service periods may be identified based on a TWT schedule associated with the wireless communication device 1800. In another aspect, the message may include a power management indicator that indicates a mode to which the wireless

communication device 1800 intends switch. In another embodiment, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the receiver 1805 may be configured to receive an indication from the second wireless device instructing the wireless communication device 1800 to switch to or to switch away from the TWT power save mode. In another aspect, the indication may include an EOSP indicator set to 1. In another embodiment, the processing system 1810, the TWT component 1824, and/or the mode component 1826 may be configured to determine whether to switch by determining if there is additional data for transmission or reception, by receiving from the second wireless device a QoS message with an EOSP indicator set to 1, or by receiving from the second wireless device a trigger message with a cascaded indicator set to 0 in which the trigger message is not intended for the wireless communication device 1800. In another embodiment, the processing system 1810, the TWT component 1824, and/or the mode component 1826 may be configured to determine a mode of the second wireless device. In another embodiment, the processing system 1810, the TWT component 1824, and/or the mode component 1826 may be configured to determine the mode of the second wireless device by receiving a second message from the second wireless device, in which second message may include a responder mode indicator that indicates whether the second wireless device is in a doze state outside of the TWT service periods. The determination of the mode of the second wireless device may be based on the responder mode indicator. In another embodiment, the processing system 1810, the TWT component 1824, and/or the mode component 1826 may be configured to determine the mode of the second wireless device by receiving a trigger message from the second wireless device. The determination of the mode of the second wireless device may be based on whether the trigger message includes resource allocations to any wireless devices. In another embodiment, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the receiver 1805 may be configured to receive from the second wireless device a second message that includes a traffic indication map, and the traffic indication map may indicate a mode of operation for the wireless communication device 1800 to select.

[00209] In another configuration, the wireless communication device 1800 may be a TWT responder with respect to operating modes. In this configuration, the processing system 1810, the TWT component 1824, the mode component 1826,

and/or the receiver 1805 may be configured to receive a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a TWT power save mode. During the TWT power save mode, the second wireless device may enter an awake state during TWT service periods and may enter a doze state outside of the TWT service periods. The processing system 1810, the TWT component 1824, and/or the mode component 1826 may be configured to store the operating mode associated with the second wireless device and to transmit to the second wireless device an acknowledgment of the operating mode switch. In an aspect, the TWT service periods may be identified based on a TWT schedule associated with the second wireless device. In another aspect, the message may include a power management indicator that indicates the operating mode to which the second wireless device intends to switch. In another embodiment, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the transmitter 1815 may be configured to transmit a QoS message that may include an EOSP indicator set to 1 to instruct the second wireless device to switch operating modes. In another embodiment, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the transmitter 1815 may be configured to transmit a responder mode indicator that indicates whether the wireless communication device 1800 is in a doze state outside of the TWT service periods. In another embodiment, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the transmitter 1815 may be configured to transmit a trigger message with unassigned resources to indicate that the wireless communication device 1800 will enter into a doze state. In another embodiment, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the transmitter 1815 may be configured to transmit a traffic indication map that indicates the operating mode for the second wireless device to select. In another embodiment, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the transmitter 1815 may be configured to transmit an indication to the second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode.

[00210] The receiver 1805, the processing system 1810, the TWT component 1824, the mode component 1826, and/or the transmitter 1815 may be configured to perform one or more functions discussed above with respect to blocks 405, 410, 415, 420,

425, 430, 435, and 440 of FIG. 4; blocks 505, 510, 515, 520, 525, and 530 of FIG. 5; blocks 705, 710, 715, 720, and 725 of FIG. 7; blocks 805, 810, 815, 820, 825, 830, and 835 of FIG. 8; blocks 1005, 1010, 1015, 1020, and 1025 of FIG. 10; and blocks 1105, 1110, 1115, 1120, 1125, 1130, 1135, and 1140 of FIG. 11. The receiver 1805 may correspond to the receiver 1712. The processing system 1810 may correspond to the processor 1704. The transmitter 1815 may correspond to the transmitter 1710. The TWT component 1824 may correspond to the TWT component 126, the TWT component 124, and/or the TWT component 1724.

[00211] In one configuration, the wireless communication device 1800 may be a TWT requester for solicit TWTs. In this configuration, the wireless communication device 1800 may include means for transmitting a first message that includes a first trigger field to a second wireless device (e.g., a TWT responder). The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the second wireless device at a start of a TWT service period. The wireless communication device 1800 may include means for receiving a second message from the second wireless device. The second message may include a second trigger field based on the first message. The second trigger field may indicate whether the second wireless device will transmit the trigger message at the start of the TWT service period. In an aspect, the first message may include a requested TWT, the first trigger field may be set to 1, and the first message may request the trigger message to be sent at the requested TWT. In another aspect, the second message may include a scheduled TWT, the second trigger field may be set to 1, and the second message may indicate that the second wireless device may transmit the trigger message at the scheduled TWT. In another aspect, the scheduled TWT may be different from a requested TWT included in the first message. In one embodiment, the wireless communication device 1800 may include means for determining a TWT schedule based on the received second message and means for determining whether to transmit to the second wireless device based on the determined TWT schedule. In this embodiment, the means for determining the TWT schedule may be configured to determine whether the TWT schedule is an implicit TWT schedule or an explicit TWT schedule based on the received second message and to determine one or more TWTs associated with the TWT schedule based on the received second message. In another embodiment, the means for determining whether to transmit may be configured to determine to transmit during

the TWT service period when a trigger message is received from the second wireless device or to determine to transmit outside of the TWT service period based on EDCA parameters associated with AC_BE or AC_BK. In another aspect, the wireless communication device 1800 may determine to transmit during the TWT service period based on the received trigger message, and the transmission may not based on EDCA contention. In another embodiment, the wireless communication device 1800 may include means for receiving a trigger message based on the determined TWT schedule. The trigger message may include a cascaded indicator that indicates whether the second wireless device will transmit another trigger message after the trigger message in the TWT service period. In another embodiment, the wireless communication device 1800 may include means for receiving a TWT information message from the second wireless device, and the TWT information message may include a next TWT value. The wireless communication device 1800 may include means for updating the TWT schedule based on the received TWT information message. In another embodiment, the TWT schedule may be the implicit TWT schedule, and the wireless communication device 1800 may include means for transmitting a TWT information message to the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another aspect, the first message may include a TWT channel indicator that indicates a channel and a channel width that the wireless communication device 1800 may use for communicating with the second wireless device during the TWT service period. In another aspect, the first message may include an OFDMA bitmap that indicates one or more OFDMA channels and channel widths to be used for communicating with the second wireless device.

[00212] In another configuration, the wireless communication device 1800 may be a TWT responder for solicit TWTs. In this configuration, the wireless communication device 1800 may include means for receiving, from a second wireless device, a first message that includes a first trigger field. The first trigger field may indicate whether the first message includes a request for a trigger message to be sent by the wireless communication device 1800 at a start of a TWT service period. The wireless communication device 1800 may include means for determining a TWT schedule based on the received first message. The wireless communication device

1800 may include means for transmitting a second message to the second wireless device. The second message may include the TWT schedule and a second trigger field based on the determined TWT schedule. The second trigger field may indicate whether the wireless communication device 1800 may transmit the trigger message at the start of the TWT service period. In an aspect, the first message may include a requested TWT, the first trigger field may be set to 1, and the first message may request the trigger message to be sent at the requested TWT. In another aspect, the second message may include a scheduled TWT, the second trigger field may be set to 1, and the second message may indicate that the wireless communication device 1800 will transmit the trigger message at the scheduled TWT. In another aspect, the scheduled TWT may be different from a requested TWT included in the first message. In an embodiment, the means for determining the TWT schedule may be configured to determine if the first trigger field includes the request for the trigger message and to schedule one or more TWTs for the second wireless device if the first trigger field includes the request for the trigger message. In another embodiment, the wireless communication device 1800 may include means for transmitting a TWT information message that includes a next TWT value that is different from all TWT values associated with the TWT schedule included in the second message. In another embodiment, the TWT schedule may be an implicit TWT schedule, and the wireless communication device 1800 may include means for receiving a TWT information message from the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another aspect, the second message may include a TWT channel indicator that indicates a channel and a channel width to be used for communicating between the wireless communication device 1800 and the second wireless device during the TWT service period. In another embodiment, the wireless communication device 1800 may include means for transmitting a trigger message that includes a cascaded indicator. The cascaded indicator may indicate whether the wireless communication device 1800 will transmit another trigger message after the trigger message in the TWT service period. In another aspect, the second message may include a TWT protection indicator that indicates whether message exchanged with the wireless communication device 1800 based on the TWT schedule are to be preceded by an RTS and a CTS message exchange.

[00213] In another configuration, the wireless communication device 1800 may broadcast TWTs to other wireless devices. In this configuration, the wireless communication device 1800 may include means for determining a TWT schedule and means for broadcasting a message that includes the TWT schedule to other wireless devices. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. In an aspect, the broadcast TWT schedule may include non-negotiable TWT parameters for communicating between the wireless communication device 1800 and at least one wireless device of the wireless devices. In another aspect, the message may further include a trigger field that indicates whether the wireless communication device 1800 will transmit a trigger message at a start of a TWT service period. In another aspect, the message may include a TWT flow identifier field that indicates a type of data flow allowed during a TWT service period. In another aspect, the type of data flow allowed may include MU OFDMA random access for wireless devices unassociated with the wireless communication device 1800, MU OFDMA random access for wireless devices associated with the wireless communication device 1800, MU DL OFDMA scheduled access for wireless devices indicated in a TIM, MU UL OFDMA scheduled access for wireless devices indicated in the TIM, MU UL MIMO scheduled access for wireless devices indicated in the TIM, MU DL MIMO scheduled access for wireless devices indicated in the TIM. In another aspect, the TWT flow identifier field may indicates one of the following types of allowed data flows: no constraints on a type of message to be exchanged with the wireless communication device 1800, messages containing feedback information or management information can be exchanged with the wireless communication device 1800 and trigger messages from the wireless communication device 1800 do not include resource units for random access, messages containing feedback information or management information can be exchanged with the wireless communication device 1800 and trigger messages from the wireless communication device 1800 include resource units for random access, messages containing quality of service information can be exchanged with the wireless communication device 1800, or no traffic is expected to be communicated to or from the wireless communication device 1800. In another aspect, the TWT schedule may be an implicit TWT schedule or an explicit TWT schedule. In another aspect, the TWT schedule may be an explicit TWT schedule, the TWT schedule may includes one or more TWT

parameter sets, and each TWT parameter set may correspond to a scheduled TWT. In another embodiment, the TWT schedule may be an implicit TWT schedule, and the wireless communication device 1800 may include means for transmitting a TWT information message to the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another embodiment, the wireless communication device 1800 may include means for transmitting a TWT information message to the second wireless device, and the TWT information message may indicate a different scheduled TWT than in the TWT schedule in the broadcasted message. In another embodiment, the wireless communication device 1800 may include means for transmitting a trigger message based on the TWT schedule. The trigger message may include a cascaded indicator that indicates whether the wireless communication device 1800 will transmit additional trigger messages in the TWT service period. In another aspect, the message may include a TWT group assignment field, and the TWT group assignment field may include a range of identifiers that identifies a group of wireless devices scheduled to wake up at a TWT during a TWT service period. In another aspect, the message may include a repetition indicator, and the repetition indicator may indicate a number of TWT service periods for which a scheduled TWT indicated in the message are valid. In another aspect, the message may include a TWT protection indicator that indicates whether messages exchanged with the wireless communication device 1800 based on the TWT schedule are to be preceded by an RTS and a CTS message exchange.

[00214] In another configuration, the wireless communication device 1800 may receive broadcast TWTs and determine whether to join the broadcast TWT. In this configuration, the wireless communication device 1800 may include means for receiving from a second wireless device a message that includes a TWT schedule. The message may include a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule. The wireless communication device 1800 may include means for determining one or more TWTs for the wireless communication device 1800 based on the TWT schedule. In an aspect, the broadcast TWT schedule may include non-negotiable TWT parameters for communicating between the wireless communication device 1800 and the second wireless device. In another aspect, the message may include a trigger field that indicates whether the second wireless

device will transmit a trigger message at a start of a TWT service period. In another aspect, the message may include a TWT flow identifier field that indicates a type of data flow allowed during a TWT service period. In another aspect, the TWT flow identifier field may indicate one of the following: no constraints on a type of message to be exchanged with the second wireless device, messages containing feedback information or management information can be exchanged with the second wireless device and trigger messages from the second wireless device do not include resource units for random access, messages containing feedback information or management information can be exchanged with the second wireless device and trigger messages from the second wireless device include resource units for random access, messages containing quality of service information can be exchanged with the second wireless device, or no traffic is expected to be communicated to or from the second wireless device. In another aspect, the TWT schedule may be an implicit TWT schedule or an explicit TWT schedule. In another aspect, the TWT schedule may be an explicit TWT schedule, the TWT schedule may include one or more TWT parameter sets, and each TWT parameter set may correspond to a scheduled TWT. In another aspect, the TWT schedule may be an implicit TWT schedule, and the wireless communication device 1800 may include means for receiving a TWT information message from the second wireless device. The TWT information message may indicate a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended. In another embodiment, the wireless communication device 1800 may include means for receiving a TWT information message from the second wireless device. The TWT information message may indicate a different scheduled TWT than in the received message. In another aspect, the message may include a repetition indicator, and the repetition indicator may indicate a number of TWT service periods for which a scheduled TWT indicated in the message are valid. In another embodiment, the wireless communication device 1800 may include means for receiving a trigger message based on the determined one or more TWTs. In another aspect, the trigger message may include a cascaded indicator that indicates whether the second wireless device will transmit additional trigger messages after the trigger message in a TWT service period. In another embodiment, the wireless communication device 1800 may include means for determining to transmit to the second wireless device during a TWT service period when the trigger message is received from the second wireless

device and means for determining to transmit to the second wireless device outside of the TWT service period based on EDCA parameters associated with an AC_BE or an AC_BK.

[00215] In another configuration, the wireless communication device 1800 may be a TWT requester determining whether to switch operating modes. In this configuration, the wireless communication device 1800 may include means for determining whether to switch to an active mode, a power save mode, or a TWT power save mode. During the TWT power save mode, the wireless communication device 1800 may enter an awake state during TWT service periods and may enter a doze state outside of the TWT service periods. The wireless communication device 1800 may include means for transmitting a message to a second wireless device based on the determination. In another aspect, the TWT service periods may be identified based on a TWT schedule associated with the wireless communication device 1800. In another aspect, the message may include a power management indicator that indicates a mode to which the wireless communication device 1800 intends switch. In another embodiment, the wireless communication device 1800 may include means for receiving an indication from the second wireless device instructing the wireless communication device 1800 to switch to or to switch away from the TWT power save mode. In another aspect, the indication may include an EOSP indicator set to 1. In another embodiment, the means for determining whether to switch may be configured to determine if there is additional data for transmission or reception, to receive from the second wireless device a QoS message with an EOSP indicator set to 1, or to receive from the second wireless device a trigger message with a cascaded indicator set to 0 in which the trigger message is not intended for the wireless communication device 1800. In another embodiment, the wireless communication device 1800 may include means for determining a mode of the second wireless device. In another embodiment, the means for determining the mode of the second wireless device may be configured to receive a second message from the second wireless device, in which second message may include a responder mode indicator that indicates whether the second wireless device is in a doze state outside of the TWT service periods. The determination of the mode of the second wireless device may be based on the responder mode indicator. In another embodiment, the means for determining the mode of the second wireless device may be configured to receive a trigger message from the second wireless

device. The determination of the mode of the second wireless device may be based on whether the trigger message includes resource allocations to any wireless devices. In another embodiment, the wireless communication device 1800 may include means for receiving from the second wireless device a second message that includes a traffic indication map, and the traffic indication map may indicate a mode of operation for the wireless communication device 1800 to select.

[00216] In another configuration, the wireless communication device 1800 may be a TWT responder with respect to operating modes. In this configuration, the wireless communication device 1800 may include means for receiving a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a TWT power save mode. During the TWT power save mode, the second wireless device may enter an awake state during TWT service periods and may enter a doze state outside of the TWT service periods. The wireless communication device 1800 may include means for storing the operating mode associated with the second wireless device and means for transmitting to the second wireless device an acknowledgment of the operating mode switch. In an aspect, the TWT service periods may be identified based on a TWT schedule associated with the second wireless device. In another aspect, the message may include a power management indicator that indicates the operating mode to which the second wireless device intends to switch. In another embodiment, the wireless communication device 1800 may include means for transmitting a QoS message that may include an EOSP indicator set to 1 to instruct the second wireless device to switch operating modes. In another embodiment, the wireless communication device 1800 may include means for transmitting a responder mode indicator that indicates whether the wireless communication device 1800 is in a doze state outside of the TWT service periods. In another embodiment, the wireless communication device 1800 may include means for transmitting a trigger message with unassigned resources to indicate that the wireless communication device 1800 will enter into a doze state. In another embodiment, the wireless communication device 1800 may include means for transmitting a traffic indication map that indicates the operating mode for the second wireless device to select. In another embodiment, the wireless communication device 1800 may include means for transmitting an indication to the

second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode.

[00217] For example, means for transmitting may include the processing system 1810, the TWT component 1824, and/or the transmitter 1815. Means for receiving may include the processing system 1810, the TWT component 1824, and/or the receiver 1805. Means for determining a TWT schedule based on the received second message may include the processing system 1810 and/or the TWT component 1824. Means for determining whether to transmit to the second wireless device based on the determined TWT schedule may include the processing system 1810 and/or the TWT component 1824. Means for updating may include the processing system 1810 and/or the TWT component 1824. Means for determining a TWT schedule based on the received first message may include the processing system 1810 and/or the TWT component 1824. Means for determining the TWT schedule may include the processing system 1810 and/or the TWT component 1824. Means for broadcasting may include the processing system 1810, the TWT component 1824, and/or the transmitter 1815. Means for determining one or more TWTs may include the processing system 1810 and/or the TWT component 1824. Means for determining to transmit to the second wireless device during a TWT service period may include the processing system 1810 and/or the TWT component 1824. Means for determining to transmit to the second wireless device outside of the TWT service period may include the processing system 1810 and/or the TWT component 1824. Means for determining whether to switch may include the processing system 1810, the mode component 1826, and/or the TWT component 1824. Means for determining a mode of the second wireless device may include the processing system 1810, the TWT component 1824, and/or the mode component 1826. Means for storing may include the processing system 1810, the TWT component 1824, and/or the mode component 1826.

[00218] The various operations of methods described above may be performed by any suitable means capable of performing the operations, such as various hardware and/or software component(s), circuits, and/or module(s). Generally, any operations illustrated in the Figures may be performed by corresponding functional means capable of performing the operations.

[00219] The various illustrative logical blocks, components and circuits described in connection with the present disclosure may be implemented or performed with a

general purpose processor, a DSP, an ASIC, an FPGA or other PLD, discrete gate or transistor logic, discrete hardware components or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any commercially available processor, controller, microcontroller or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00220] In one or more aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, compact disc (CD) ROM (CD-ROM) or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Thus, computer readable medium comprises a non-transitory computer readable medium (e.g., tangible media).

[00221] The methods disclosed herein comprise one or more steps or actions for achieving the described method. The method steps and/or actions may be interchanged with one another without departing from the scope of the claims. In other words, unless a specific order of steps or actions is specified, the order and/or

use of specific steps and/or actions may be modified without departing from the scope of the claims.

[00222] Thus, certain aspects may comprise a computer program product for performing the operations presented herein. For example, such a computer program product may comprise a computer readable medium having instructions stored (and/or encoded) thereon, the instructions being executable by one or more processors to perform the operations described herein. For certain aspects, the computer program product may include packaging material.

[00223] Further, it should be appreciated that components and/or other appropriate means for performing the methods and techniques described herein can be downloaded and/or otherwise obtained by a user terminal and/or base station as applicable. For example, such a device can be coupled to a server to facilitate the transfer of means for performing the methods described herein. Alternatively, various methods described herein can be provided via storage means (e.g., RAM, ROM, a physical storage medium such as a CD or floppy disk, etc.), such that a user terminal and/or base station can obtain the various methods upon coupling or providing the storage means to the device. Moreover, any other suitable technique for providing the methods and techniques described herein to a device can be utilized.

[00224] It is to be understood that the claims are not limited to the precise configuration and components illustrated above. Various modifications, changes and variations may be made in the arrangement, operation and details of the methods and apparatus described above without departing from the scope of the claims.

[00225] While the foregoing is directed to aspects of the present disclosure, other and further aspects of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

[00226] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more.

All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 U.S.C. §112(f), unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited using the phrase "step for."

CLAIMS

WHAT IS CLAIMED IS:

1. A method of wireless communication by a first wireless device, comprising:

determining whether to switch to an active mode, a power save mode, or a target wake time (TWT) power save mode, wherein, during the TWT power save mode, the first wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods; and

transmitting a message to a second wireless device based on the determination.

2. The method of claim 1, wherein the TWT service periods are identified based on a TWT schedule associated with the first wireless device.

3. The method of claim 1, wherein the message includes a power management indicator that indicates a mode to which the first wireless device intends switch.

4. The method of claim 1, further comprising receiving an indication from the second wireless device instructing the first wireless device to switch to or to switch away from the TWT power save mode.

5. The method of claim 4, wherein the indication includes an end of service period (EOSP) indicator set to 1.

6. The method of claim 1, wherein the determining comprises:

determining if there is additional data for transmission or reception;

receiving from the second wireless device a quality of service (QoS) message with an end of service period (EOSP) indicator set to 1; or

receiving from the second wireless device a trigger message with a cascaded indicator set to 0 and the trigger message is not intended for the first wireless device.

7. The method of claim 1, further comprising determining a mode of the second wireless device.

8. The method of claim 7, wherein the determining the mode of the second wireless device comprises receiving a second message from the second wireless device, wherein second message includes a responder mode indicator that indicates whether the second wireless device is in a doze state outside of the TWT service periods, and the determination of the mode of the second wireless device is based on the responder mode indicator.

9. The method of claim 1, wherein the determining the mode of the second wireless device comprises receiving a trigger message from the second wireless device, wherein the determination of the mode of the second wireless device is based on whether the trigger message includes resource allocations to any wireless devices.

10. The method of claim 1, further comprising receiving from the second wireless device a second message that includes a traffic indication map, wherein the traffic indication map indicates a mode of operation for the first wireless device to select.

11. A method of wireless communication by a first wireless device, comprising:

receiving a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a target wake time (TWT) power save mode, wherein, during the TWT power save mode, the second wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods;

storing the operating mode associated with the second wireless device; and

transmitting to the second wireless device an acknowledgment of the operating mode switch.

12. The method of claim 11, wherein the TWT service periods are identified based on a TWT schedule associated with the second wireless device.

13. The method of claim 11, wherein the message includes a power management indicator that indicates the operating mode to which the second wireless device intends to switch.

14. The method of claim 11, further comprising transmitting a quality of service (QoS) message that includes an end of service period (EOSP) indicator set to 1 to instruct the second wireless device to switch operating modes.

15. The method of claim 11, further comprising transmitting a responder mode indicator that indicates whether the first wireless device is in a doze state outside of the TWT service periods.

16. The method of claim 11, further comprising transmitting a trigger message with unassigned resources to indicate that the first wireless device will enter into a doze state.

17. The method of claim 11, further comprising transmitting a traffic indication map that indicates the operating mode for the second wireless device to select.

18. The method of claim 11, further comprising transmitting an indication to the second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode.

19. An apparatus for wireless communication, the apparatus being a first wireless device, comprising:

means for determining whether to switch to an active mode, a power save mode, or a target wake time (TWT) power save mode, wherein, during the TWT power save mode, the first wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods; and

means for transmitting a message to a second wireless device based on the determination.

20. The apparatus of claim 19, wherein the TWT service periods are identified based on a TWT schedule associated with the first wireless device.

21. The apparatus of claim 19, wherein the message includes a power management indicator that indicates a mode to which the first wireless device intends switch.

22. The apparatus of claim 19, further comprising means for receiving an indication from the second wireless device instructing the first wireless device to switch to or to switch away from the TWT power save mode.

23. The apparatus of claim 22, wherein the indication includes an end of service period (EOSP) indicator set to 1.

24. The apparatus of claim 19, wherein the means for determining is configured to:

determine if there is additional data for transmission or reception;

receive from the second wireless device a quality of service (QoS) message with an end of service period (EOSP) indicator set to 1; or

receive from the second wireless device a trigger message with a cascaded indicator set to 0 and the trigger message is not intended for the first wireless device.

25. The apparatus of claim 19, further comprising means for determining a mode of the second wireless device.

26. The apparatus of claim 25, wherein the means for determining the mode of the second wireless device is configured to receive a second message from the second wireless device, wherein second message includes a responder mode indicator that indicates whether the second wireless device is in a doze state outside of the TWT service periods, and the determination of the mode of the second wireless device is based on the responder mode indicator.

27. The apparatus of claim 19, wherein the means for determining the mode of the second wireless device is configured to receive a trigger message from the second wireless device, and wherein the determination of the mode of the second wireless device is based on whether the trigger message includes resource allocations to any wireless devices.

28. The apparatus of claim 19, further comprising means for receiving from the second wireless device a second message that includes a traffic indication map, wherein the traffic indication map indicates a mode of operation for the first wireless device to select.

29. An apparatus for wireless communication, the apparatus being a first wireless device, comprising:

means for receiving a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a target wake time (TWT) power save mode, wherein, during the TWT power save mode, the second wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods;

means for storing the operating mode associated with the second wireless device; and

means for transmitting to the second wireless device an acknowledgment of the operating mode switch.

30. The apparatus of claim 29, wherein the TWT service periods are identified based on a TWT schedule associated with the second wireless device.

31. The apparatus of claim 29, wherein the message includes a power management indicator that indicates the operating mode to which the second wireless device intends to switch.

32. The apparatus of claim 29, further comprising means for transmitting a quality of service (QoS) message that includes an end of service period (EOSP) indicator set to 1 to instruct the second wireless device to switch operating modes.

33. The apparatus of claim 29, further comprising means for transmitting a responder mode indicator that indicates whether the first wireless device is in a doze state outside of the TWT service periods.

34. The apparatus of claim 29, further comprising means for transmitting a trigger message with unassigned resources to indicate that the first wireless device will enter into a doze state.

35. The apparatus of claim 29, further comprising means for transmitting a traffic indication map that indicates the operating mode for the second wireless device to select.

36. The apparatus of claim 29, further comprising means for transmitting an indication to the second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode.

37. An apparatus for wireless communication, the apparatus being a first wireless device, comprising:

a memory; and

at least one processor coupled to the memory and configured to:

determine whether to switch to an active mode, a power save mode, or a target wake time (TWT) power save mode, wherein, during the TWT power save mode, the first wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods; and

transmit a message to a second wireless device based on the determination.

38. The apparatus of claim 37, wherein the TWT service periods are identified based on a TWT schedule associated with the first wireless device.

39. The apparatus of claim 37, wherein the message includes a power management indicator that indicates a mode to which the first wireless device intends switch.

40. The apparatus of claim 37, wherein the at least one processor is further configured to receive an indication from the second wireless device instructing the first wireless device to switch to or to switch away from the TWT power save mode.

41. The apparatus of claim 40, wherein the indication includes an end of service period (EOSP) indicator set to 1.

42. The apparatus of claim 37, wherein the at least one processor is configured to determine by:

determining if there is additional data for transmission or reception;

receiving from the second wireless device a quality of service (QoS) message with an end of service period (EOSP) indicator set to 1; or

receiving from the second wireless device a trigger message with a cascaded indicator set to 0 and the trigger message is not intended for the first wireless device.

43. The apparatus of claim 37, wherein the at least one processor is configured to determine a mode of the second wireless device.

44. The apparatus of claim 43, wherein the at least one processor is configured to determine the mode of the second wireless device by receiving a second message from the second wireless device, wherein second message includes a responder mode indicator that indicates whether the second wireless device is in a doze state outside of the TWT service periods, and the determination of the mode of the second wireless device is based on the responder mode indicator.

45. The apparatus of claim 37, wherein the at least one processor is configured to determine the mode of the second wireless device by receiving a trigger message from the second wireless device, wherein the determination of the mode of the second wireless device is based on whether the trigger message includes resource allocations to any wireless devices.

46. The apparatus of claim 37, wherein the at least one processor is further configured to receive from the second wireless device a second message that includes a traffic indication map, wherein the traffic indication map indicates a mode of operation for the first wireless device to select.

47. An apparatus for wireless communication, the apparatus being a first wireless device, comprising:

a memory; and

at least one processor coupled to the memory and configured to:

receive a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a target wake time (TWT) power save mode,

wherein, during the TWT power save mode, the second wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods;

store the operating mode associated with the second wireless device; and

transmit to the second wireless device an acknowledgment of the operating mode switch.

48. The apparatus of claim 47, wherein the TWT service periods are identified based on a TWT schedule associated with the second wireless device.

49. The apparatus of claim 47, wherein the message includes a power management indicator that indicates the operating mode to which the second wireless device intends to switch.

50. The apparatus of claim 47, wherein the at least one processor is further configured to transmit a quality of service (QoS) message that includes an end of service period (EOSP) indicator set to 1 to instruct the second wireless device to switch operating modes.

51. The apparatus of claim 47, wherein the at least one processor is further configured to transmit a responder mode indicator that indicates whether the first wireless device is in a doze state outside of the TWT service periods.

52. The apparatus of claim 47, wherein the at least one processor is further configured to transmit a trigger message with unassigned resources to indicate that the first wireless device will enter into a doze state.

53. The apparatus of claim 47, wherein the at least one processor is further configured to transmit a traffic indication map that indicates the operating mode for the second wireless device to select.

54. The apparatus of claim 47, wherein the at least one processor is further configured to transmit an indication to the second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode.

55. A computer-readable medium of a first wireless device storing computer-executable code, comprising code to:

determine whether to switch to an active mode, a power save mode, or a target wake time (TWT) power save mode, wherein, during the TWT power save mode, the first wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods; and

transmit a message to a second wireless device based on the determination.

56. A computer-readable medium of a first wireless device storing computer-executable code, comprising code to:

receive a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a target wake time (TWT) power save mode, wherein, during the TWT power save mode, the second wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods;

store the operating mode associated with the second wireless device; and

transmit to the second wireless device an acknowledgment of the operating mode switch.

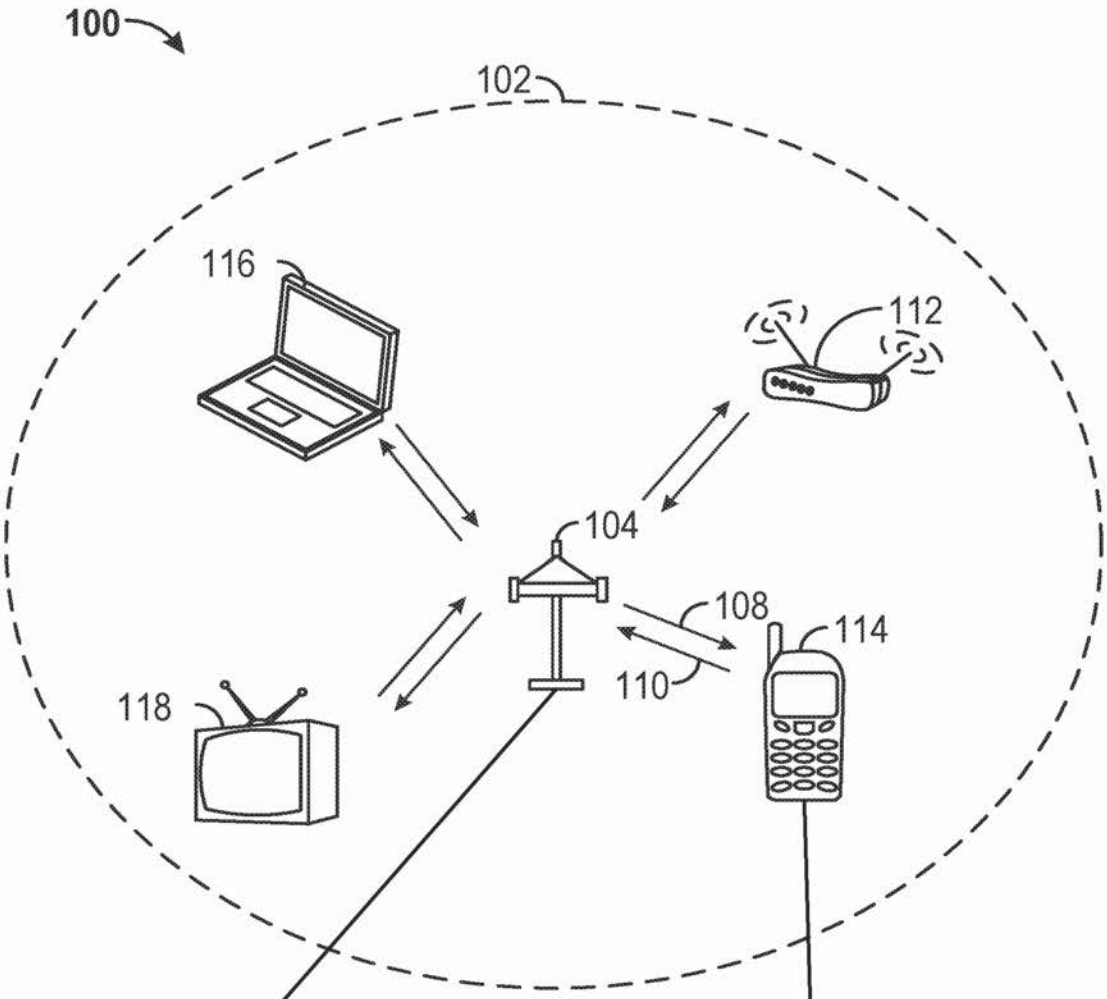
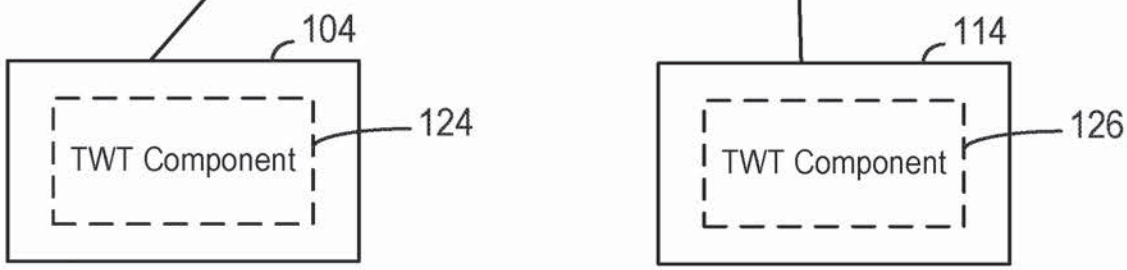

100
102
116
112
104
108
114
110
118

FIG. 1


104
TWT Component
124
114
TWT Component
126

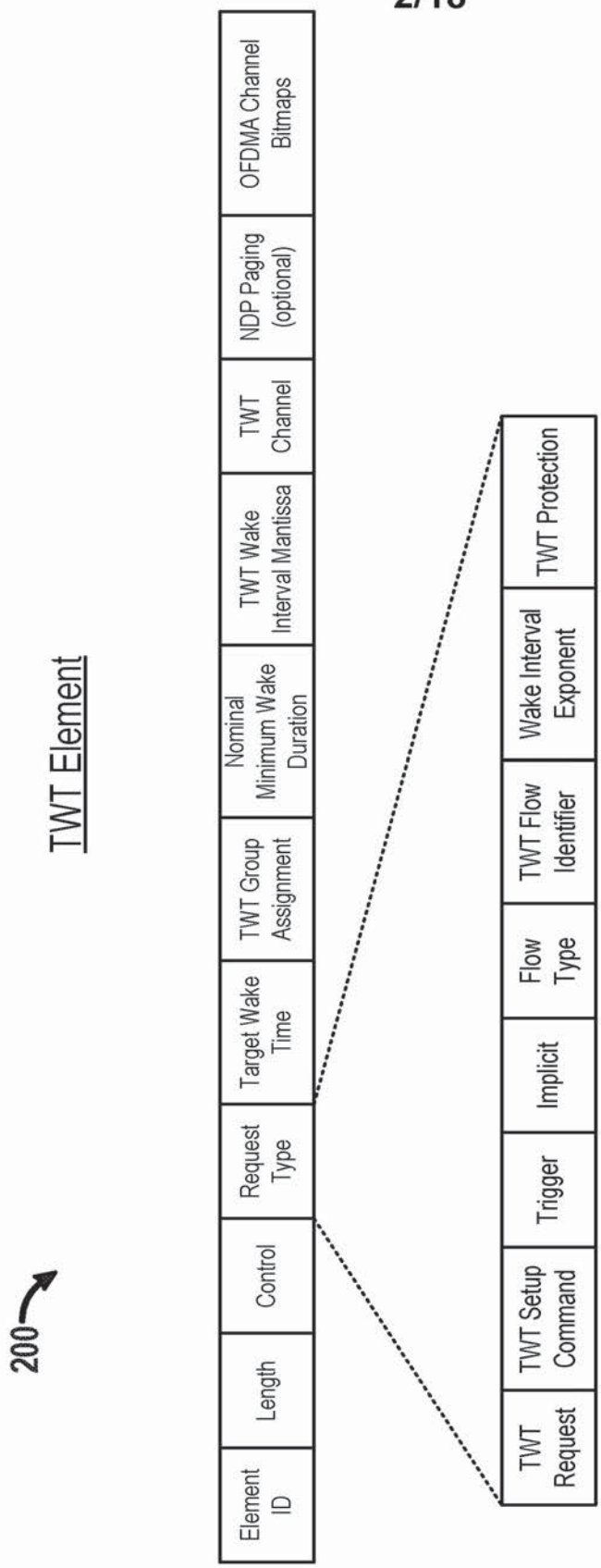

200
TWT Element
Element ID
Length
Control
Request Type
Target Wake Time
TWT Group Assignment
Nominal Minimum Wake Duration
TWT Wake Interval Mantissa
TWT Channel
NDP Paging (optional)
OFDMA Channel Bitmaps
TWT Request
TWT Setup Command
Trigger
Implicit
Flow Type
TWT Flow Identifier
Wake Interval Exponent
TWT Protection

FIG. 2

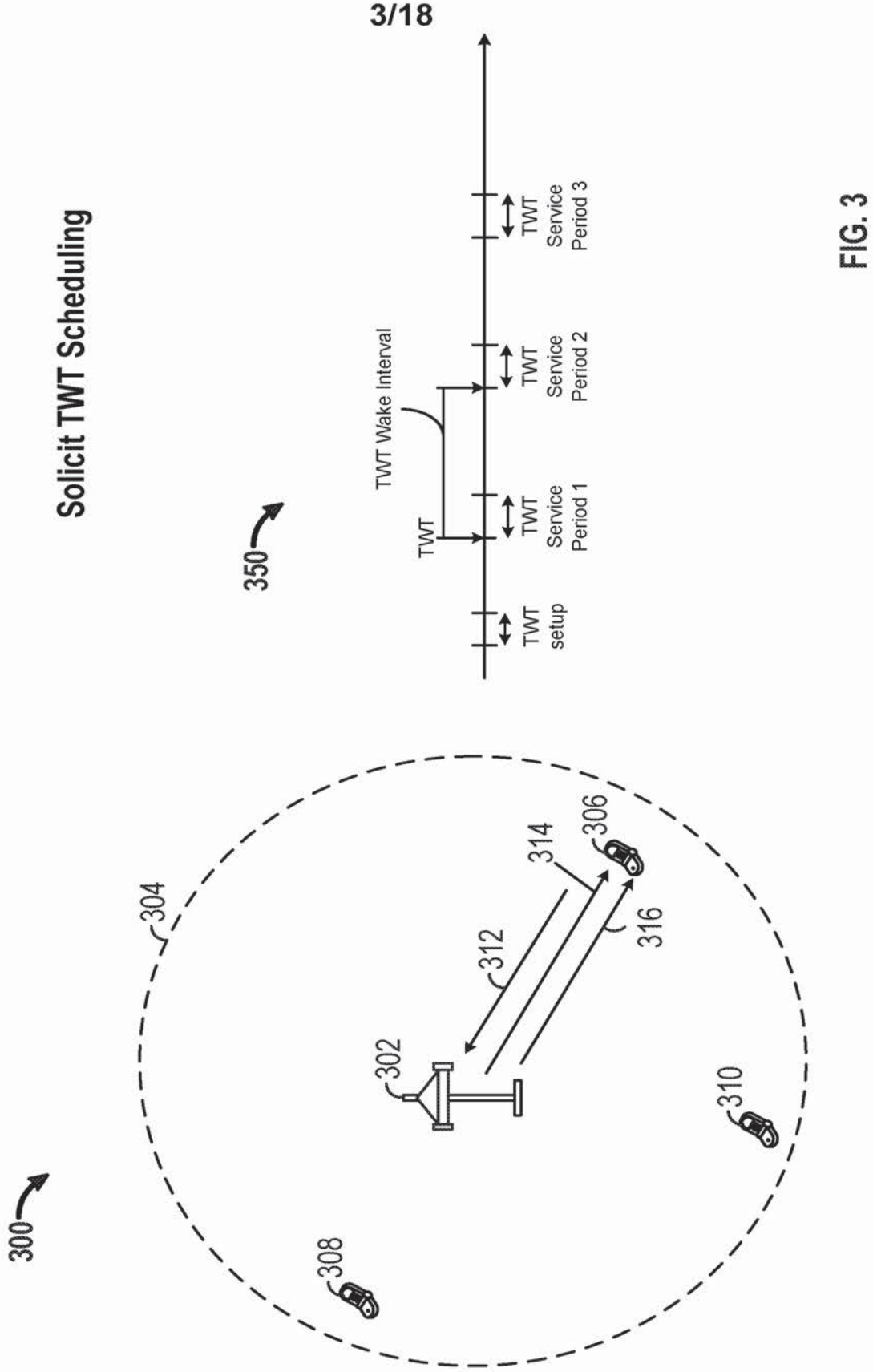

Solicit TWT Scheduling
300
304
306
308
310
312
314
316
302
350
TWT
TWT Wake Interval
TWT setup
TWT Service Period 1
TWT Service Period 2
TWT Service Period 3

FIG. 3

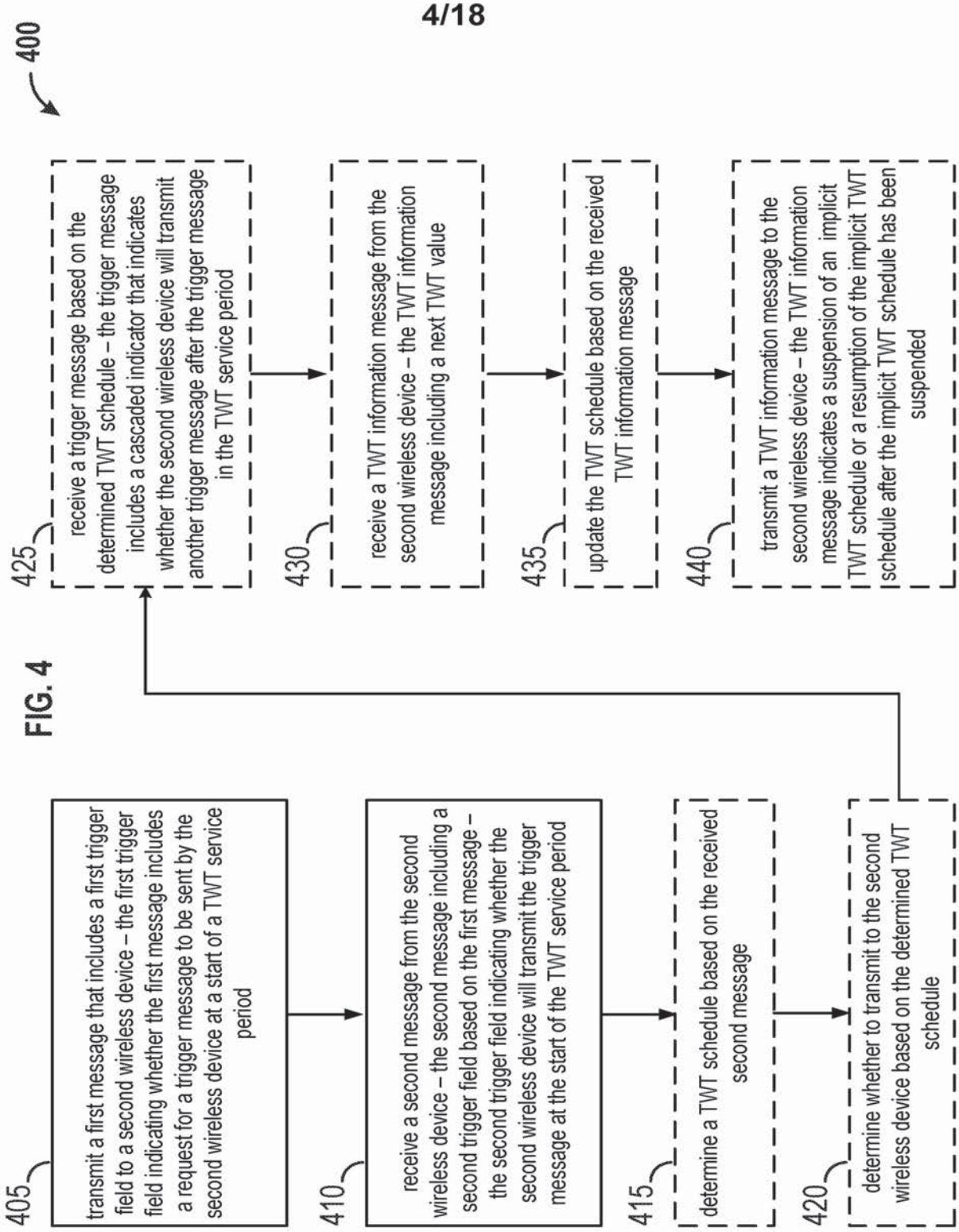

400
405
transmit a first message that includes a first trigger field to a second wireless device – the first trigger field indicating whether the first message includes a request for a trigger message to be sent by the second wireless device at a start of a TWT service period
410
receive a second message from the second wireless device – the second message including a second trigger field based on the first message – the second trigger field indicating whether the second wireless device will transmit the trigger message at the start of the TWT service period
415
determine a TWT schedule based on the received second message
420
determine whether to transmit to the second wireless device based on the determined TWT schedule
425
receive a trigger message based on the determined TWT schedule – the trigger message includes a cascaded indicator that indicates whether the second wireless device will transmit another trigger message after the trigger message in the TWT service period
430
receive a TWT information message from the second wireless device – the TWT information message including a next TWT value
435
update the TWT schedule based on the received TWT information message
440
transmit a TWT information message to the second wireless device – the TWT information message indicates a suspension of an implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended

FIG. 4

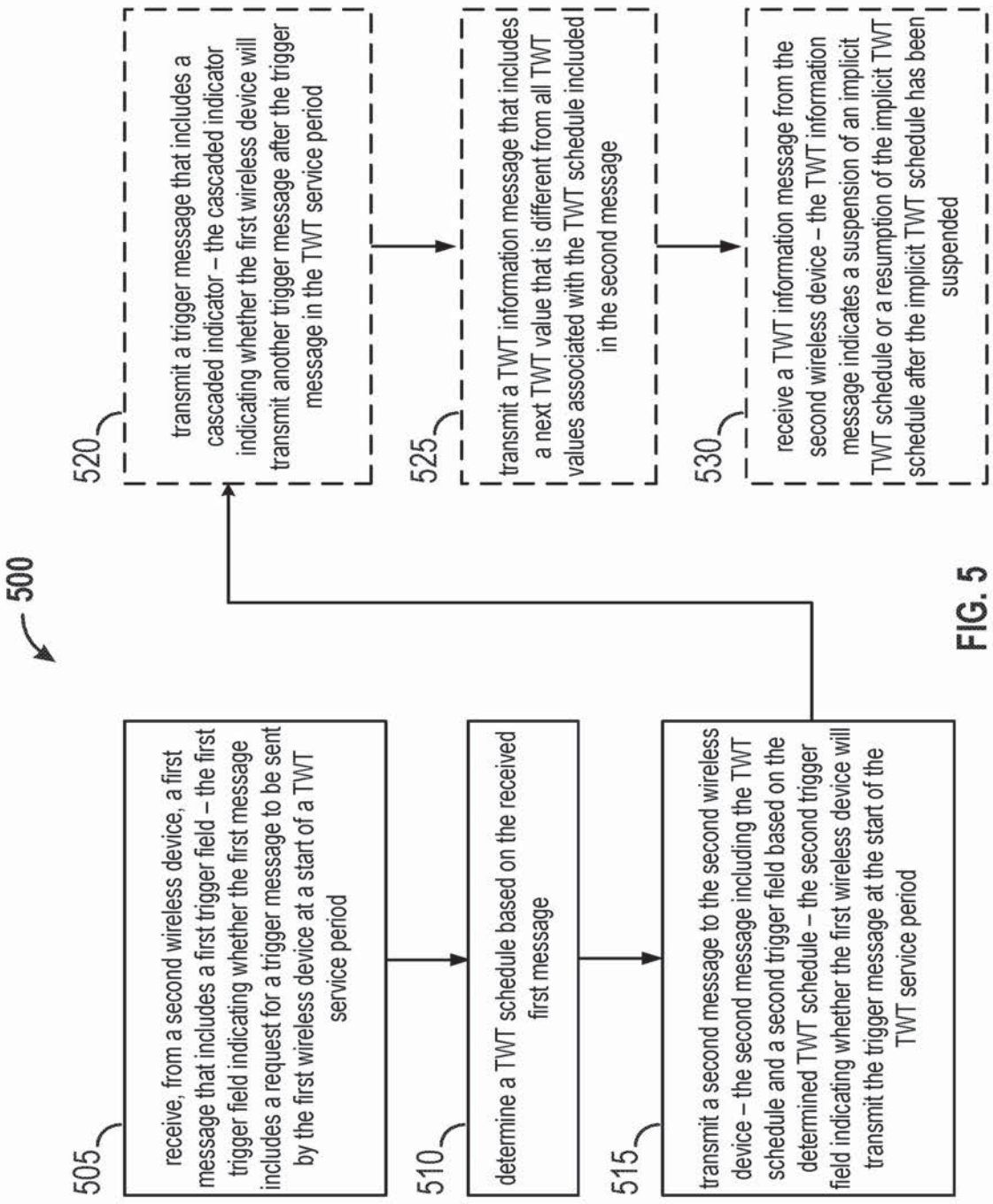
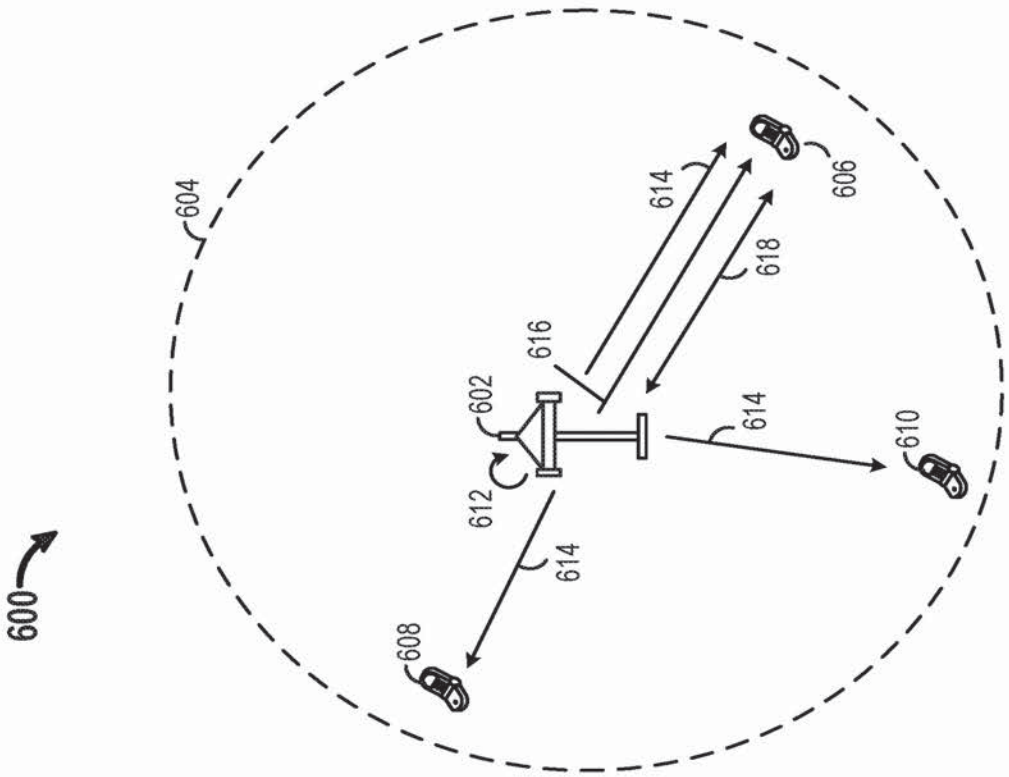

500
505
receive, from a second wireless device, a first message that includes a first trigger field – the first trigger field indicating whether the first message includes a request for a trigger message to be sent by the first wireless device at a start of a TWT service period
510
determine a TWT schedule based on the received first message
515
transmit a second message to the second wireless device – the second message including the TWT schedule and a second trigger field based on the determined TWT schedule – the second trigger field indicating whether the first wireless device will transmit the trigger message at the start of the TWT service period
520
transmit a trigger message that includes a cascaded indicator – the cascaded indicator indicating whether the first wireless device will transmit another trigger message after the trigger message in the TWT service period
525
transmit a TWT information message that includes a next TWT value that is different from all TWT values associated with the TWT schedule included in the second message
530
receive a TWT information message from the second wireless device – the TWT information message indicates a suspension of an implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended

FIG. 5


600
604
606
608
610
612
614
616
618
602

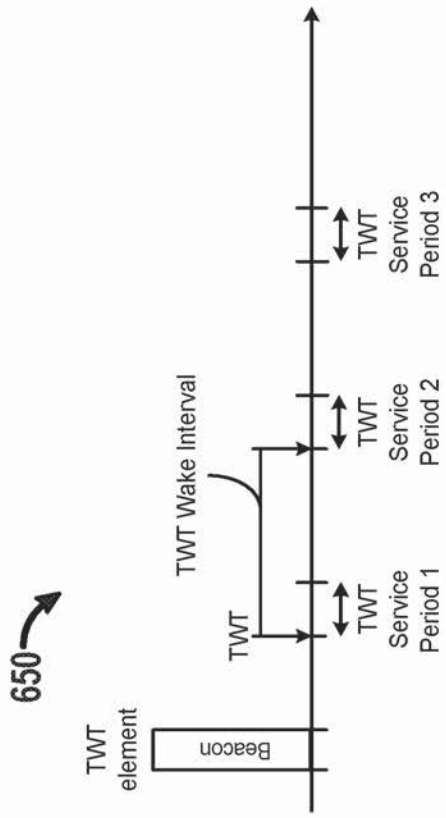

650
Broadcast TWT Scheduling
TWT element
Beacon
TWT
TWT Wake Interval
TWT Service Period 1
TWT Service Period 2
TWT Service Period 3

FIG. 6

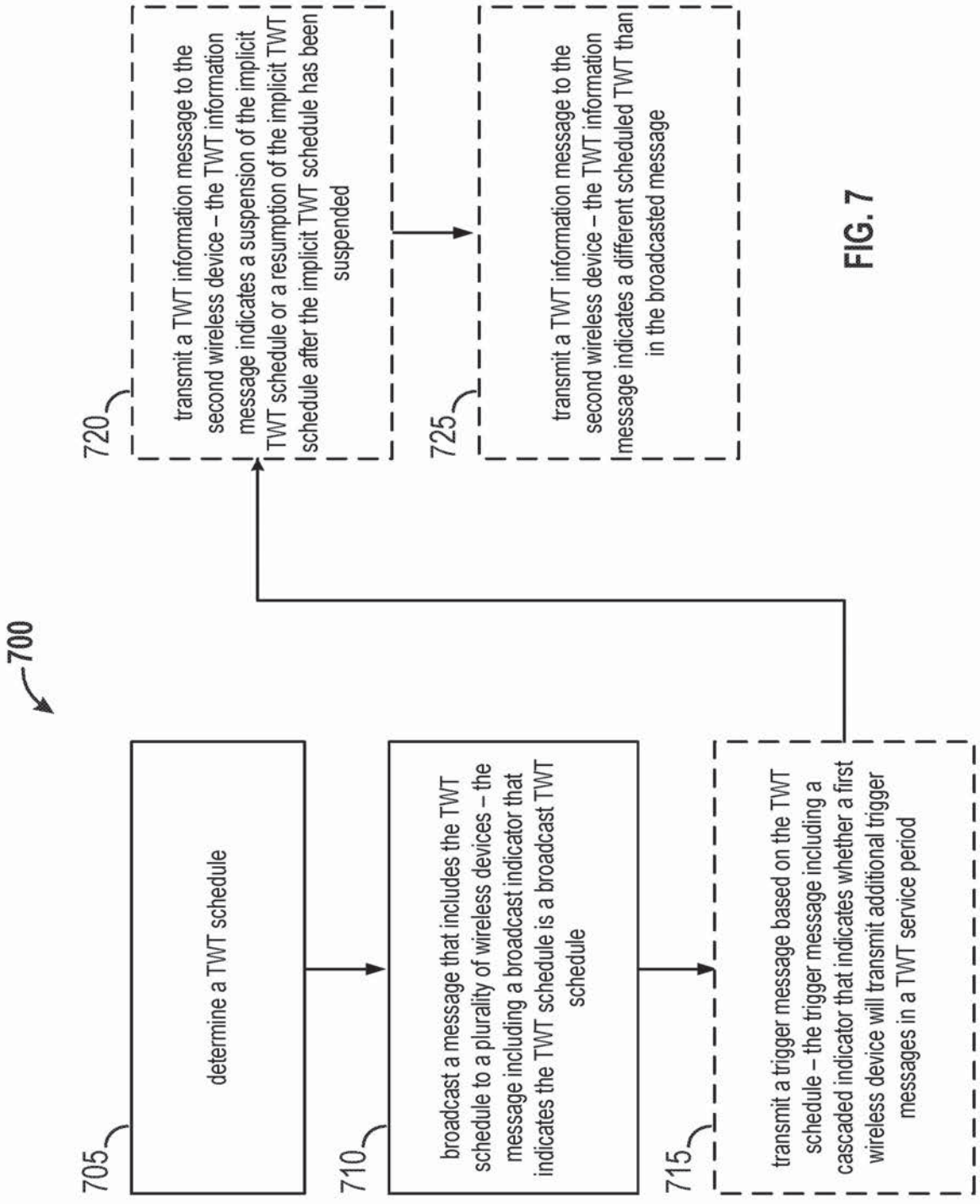

700
705
determine a TWT schedule
710
broadcast a message that includes the TWT schedule to a plurality of wireless devices – the message including a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule
715
transmit a trigger message based on the TWT schedule – the trigger message including a cascaded indicator that indicates whether a first wireless device will transmit additional trigger messages in a TWT service period
720
transmit a TWT information message to the second wireless device – the TWT information message indicates a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended
725
transmit a TWT information message to the second wireless device – the TWT information message indicates a different scheduled TWT than in the broadcasted message

FIG. 7

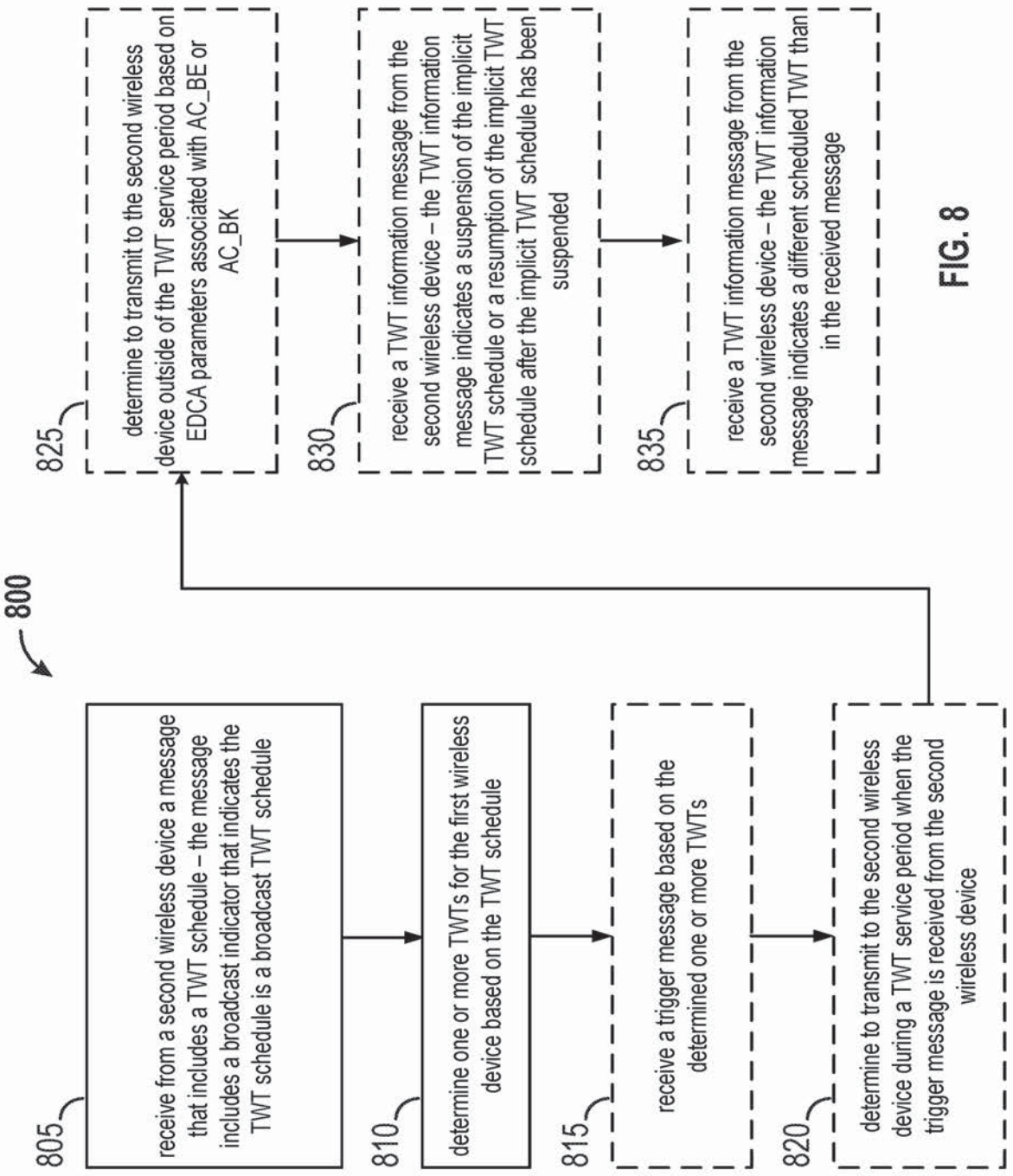

800
805
receive from a second wireless device a message that includes a TWT schedule – the message includes a broadcast indicator that indicates the TWT schedule is a broadcast TWT schedule
810
determine one or more TWTs for the first wireless device based on the TWT schedule
815
receive a trigger message based on the determined one or more TWTs
820
determine to transmit to the second wireless device during a TWT service period when the trigger message is received from the second wireless device
825
determine to transmit to the second wireless device outside of the TWT service period based on EDCA parameters associated with AC_BE or AC_BK
830
receive a TWT information message from the second wireless device – the TWT information message indicates a suspension of the implicit TWT schedule or a resumption of the implicit TWT schedule after the implicit TWT schedule has been suspended
835
receive a TWT information message from the second wireless device – the TWT information message indicates a different scheduled TWT than in the received message

FIG. 8

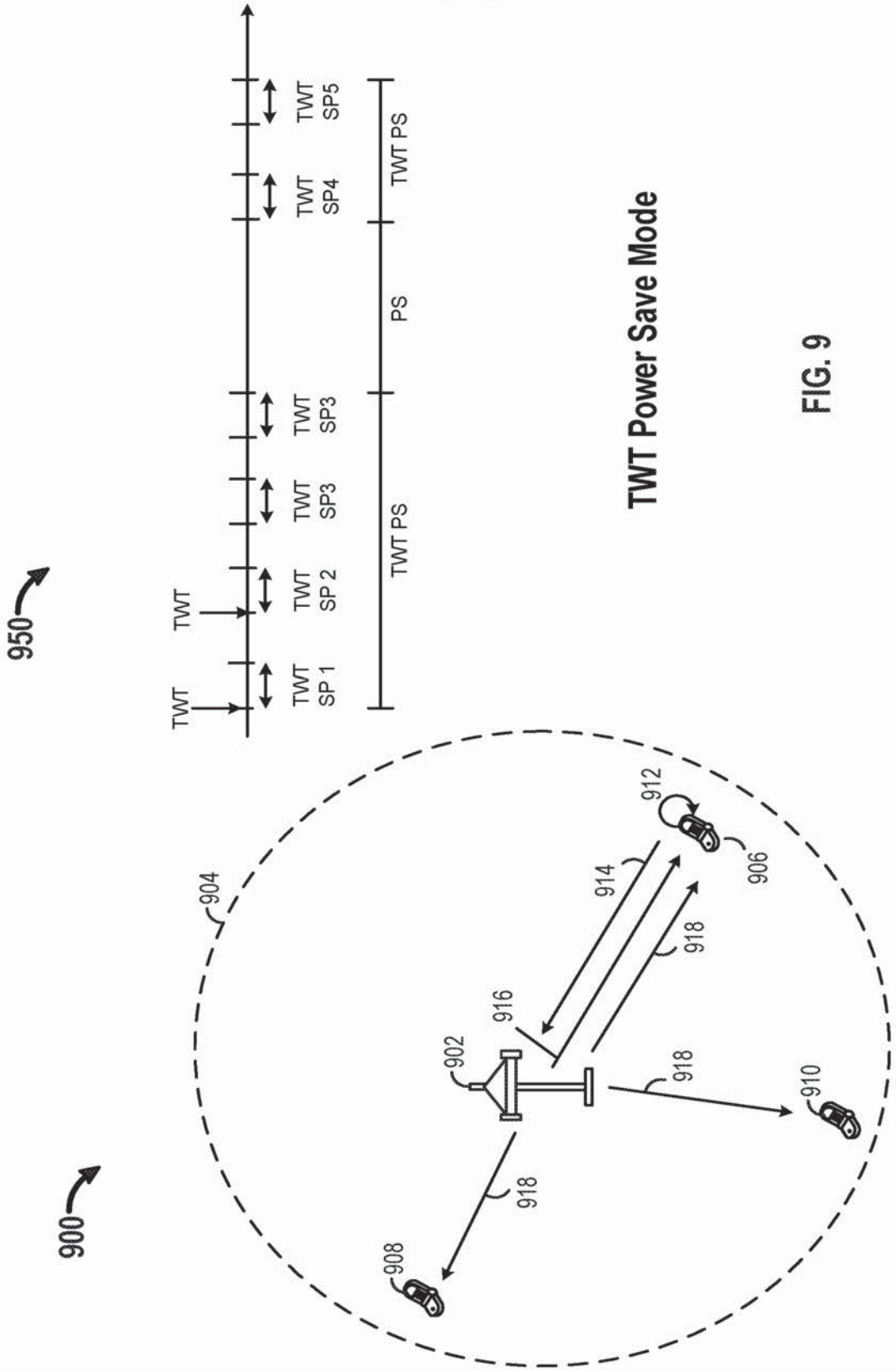

900
950
TWT
TWT
TWT SP 1
TWT SP 2
TWT SP3
TWT SP3
TWT SP4
TWT SP5
TWT PS
PS
TWT PS
TWT Power Save Mode
904
902
906
908
910
912
914
916
918
918
918

FIG. 9

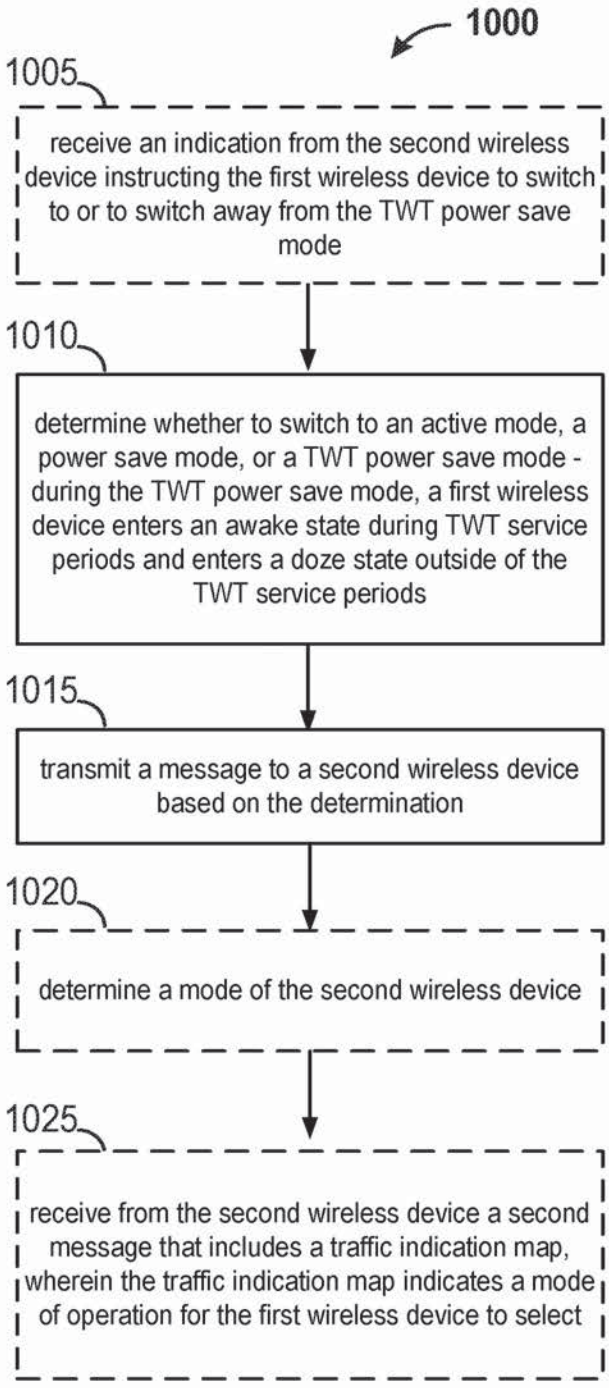

1000
1005
receive an indication from the second wireless device instructing the first wireless device to switch to or to switch away from the TWT power save mode
1010
determine whether to switch to an active mode, a power save mode, or a TWT power save mode - during the TWT power save mode, a first wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods
1015
transmit a message to a second wireless device based on the determination
1020
determine a mode of the second wireless device
1025
receive from the second wireless device a second message that includes a traffic indication map, wherein the traffic indication map indicates a mode of operation for the first wireless device to select

FIG. 10

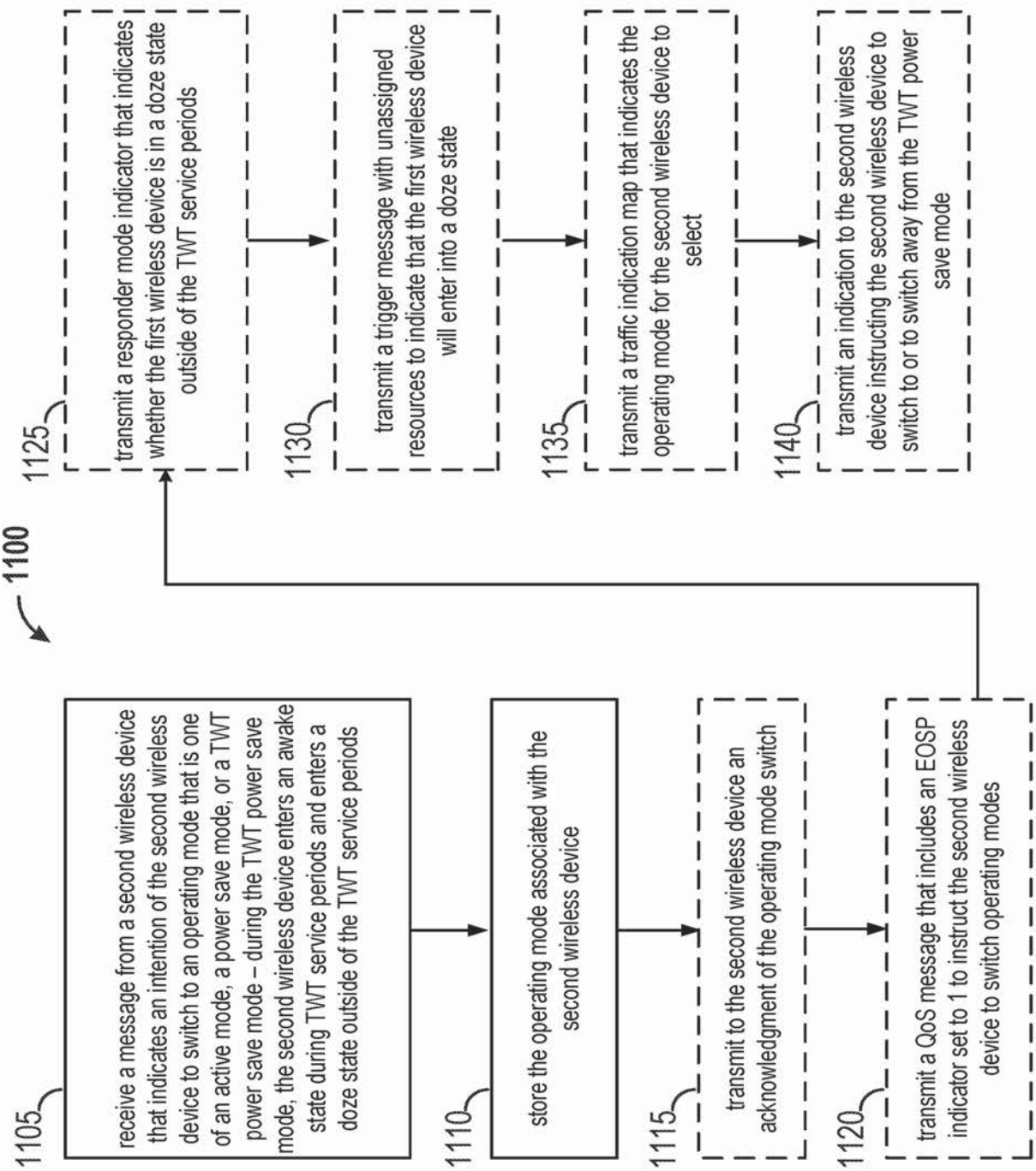
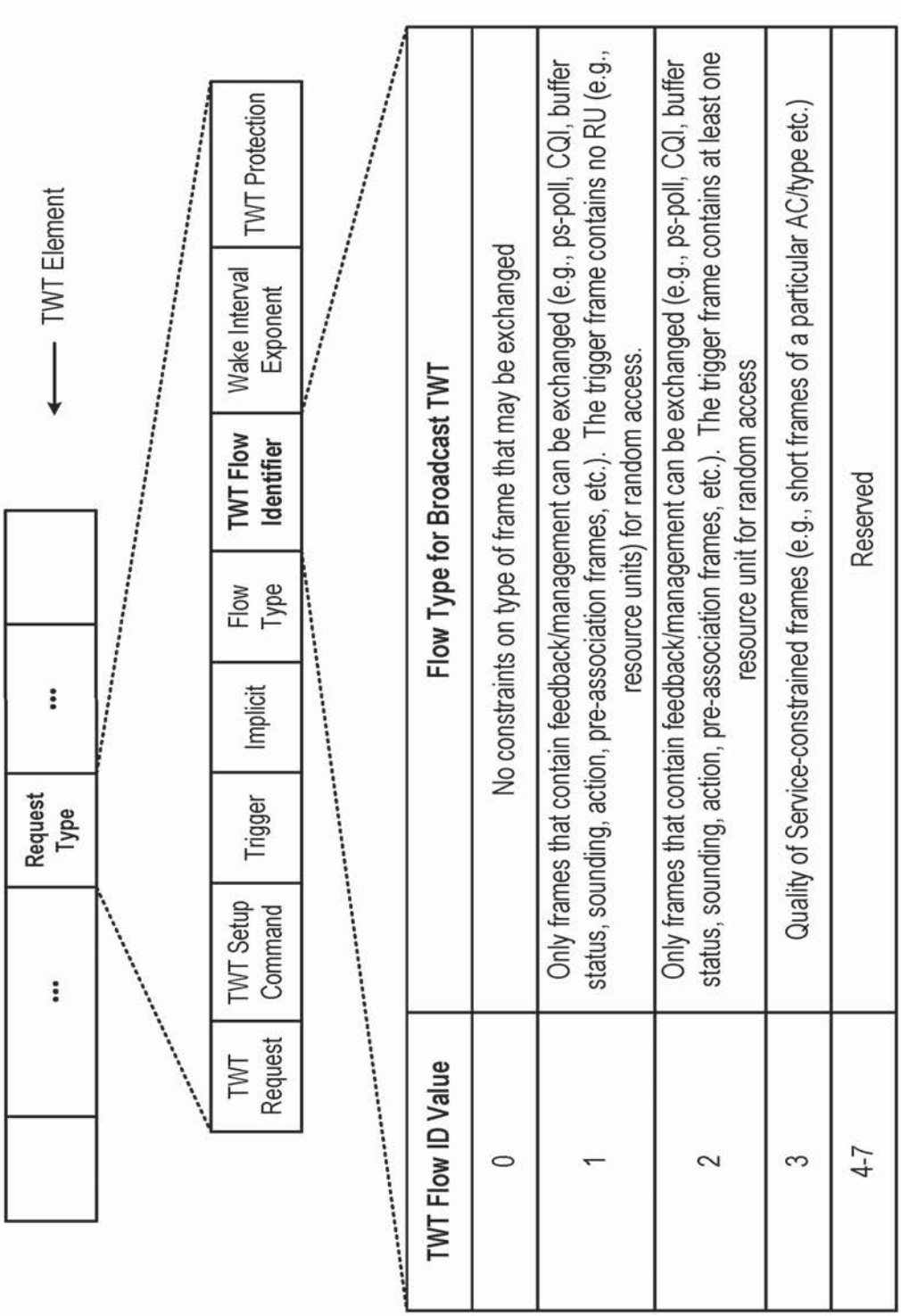

1100
1105
receive a message from a second wireless device that indicates an intention of the second wireless device to switch to an operating mode that is one of an active mode, a power save mode, or a TWT power save mode – during the TWT power save mode, the second wireless device enters an awake state during TWT service periods and enters a doze state outside of the TWT service periods
1110
store the operating mode associated with the second wireless device
1115
transmit to the second wireless device an acknowledgment of the operating mode switch
1120
transmit a QoS message that includes an EOSP indicator set to 1 to instruct the second wireless device to switch operating modes
1125
transmit a responder mode indicator that indicates whether the first wireless device is in a doze state outside of the TWT service periods
1130
transmit a trigger message with unassigned resources to indicate that the first wireless device will enter into a doze state
1135
transmit a traffic indication map that indicates the operating mode for the second wireless device to select
1140
transmit an indication to the second wireless device instructing the second wireless device to switch to or to switch away from the TWT power save mode

FIG. 11



TWT Flow ID Value	Flow Type for Broadcast TWT
0	No constraints on type of frame that may be exchanged
1	Only frames that contain feedback/management can be exchanged (e.g., ps-poll, CQI, buffer status, sounding, action, pre-association frames, etc.). The trigger frame contains no RU (e.g., resource units) for random access.
2	Only frames that contain feedback/management can be exchanged (e.g., ps-poll, CQI, buffer status, sounding, action, pre-association frames, etc.). The trigger frame contains at least one resource unit for random access
3	Quality of Service-constrained frames (e.g., short frames of a particular AC/type etc.)
4-7	Reserved

FIG. 12

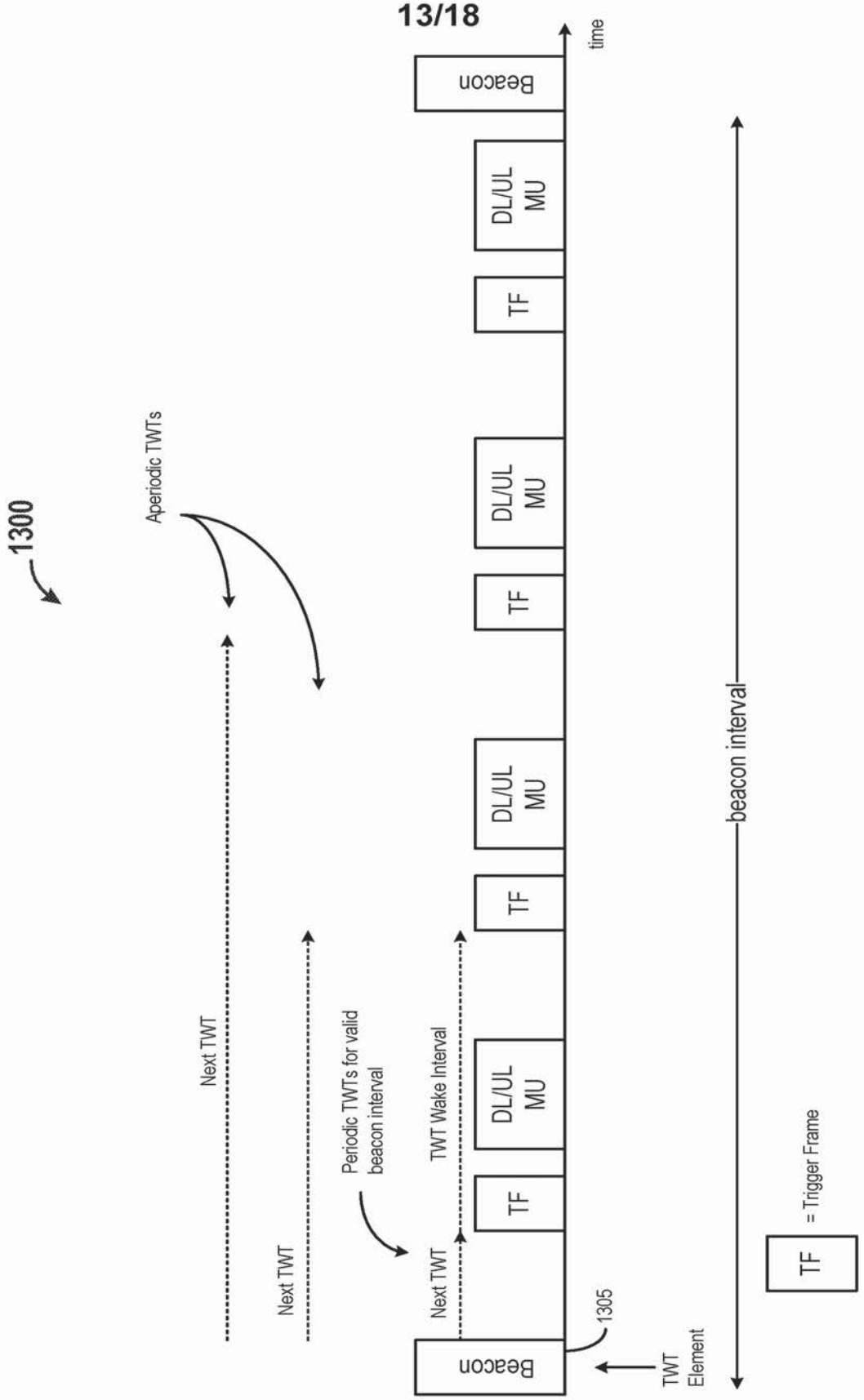

1300
Aperiodic TWTs
Next TWT
Next TWT
Periodic TWTs for valid beacon interval
TWT Wake Interval
Next TWT
Beacon
1305
TWT Element
TF
DL/UL MU
TF
DL/UL MU
TF
DL/UL MU
TF
Beacon
time
beacon interval
TF = Trigger Frame

FIG. 13

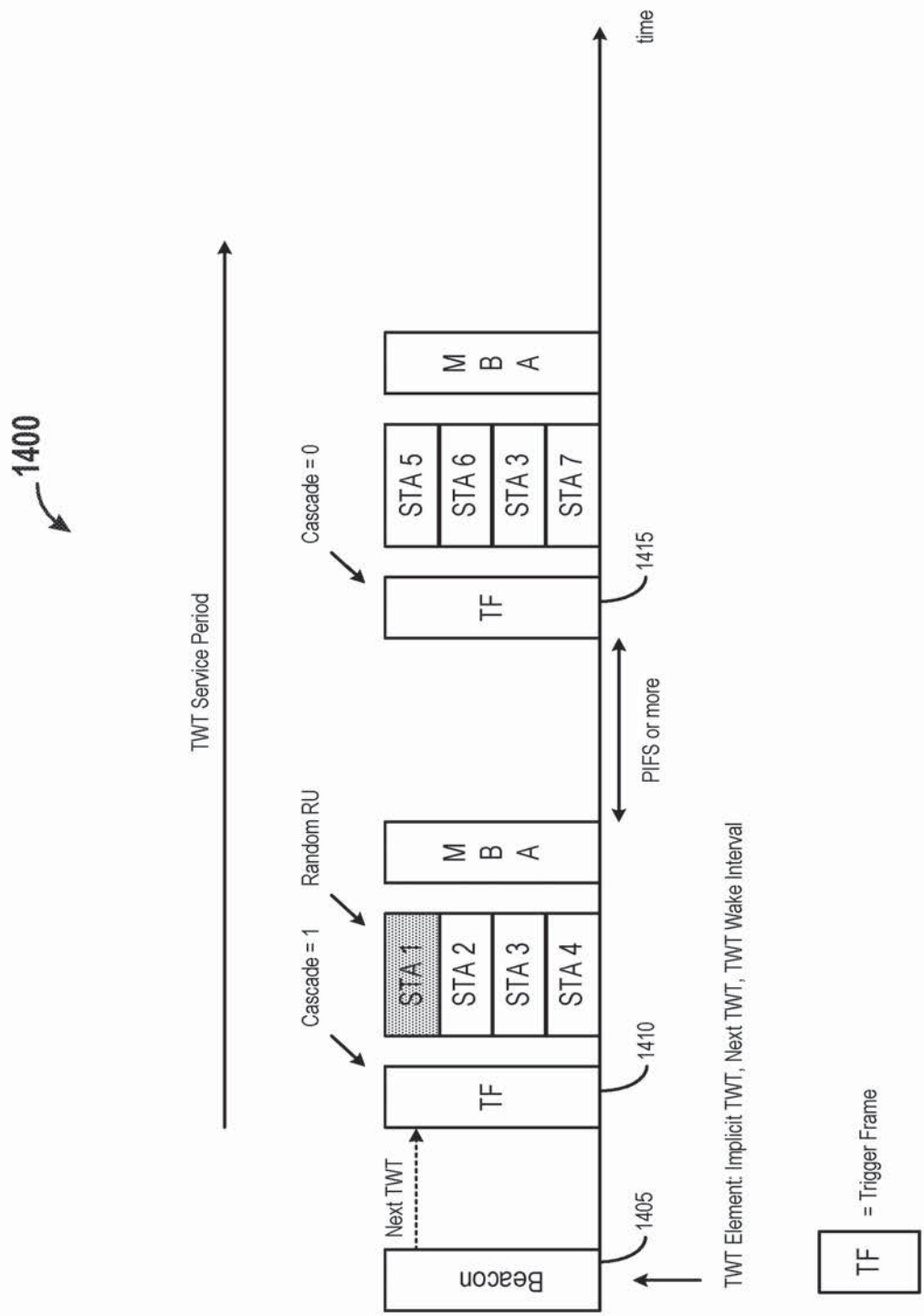

1400
TWT Service Period
time
Beacon
1405
Next TWT
TF
1410
Cascade = 1
Random RU
STA 1
STA 2
STA 3
STA 4
M B A
PIFS or more
TF
1415
Cascade = 0
STA 5
STA 6
STA 3
STA 7
M B A
TWT Element: Implicit TWT, Next TWT, TWT Wake Interval
TF = Trigger Frame

FIG. 14

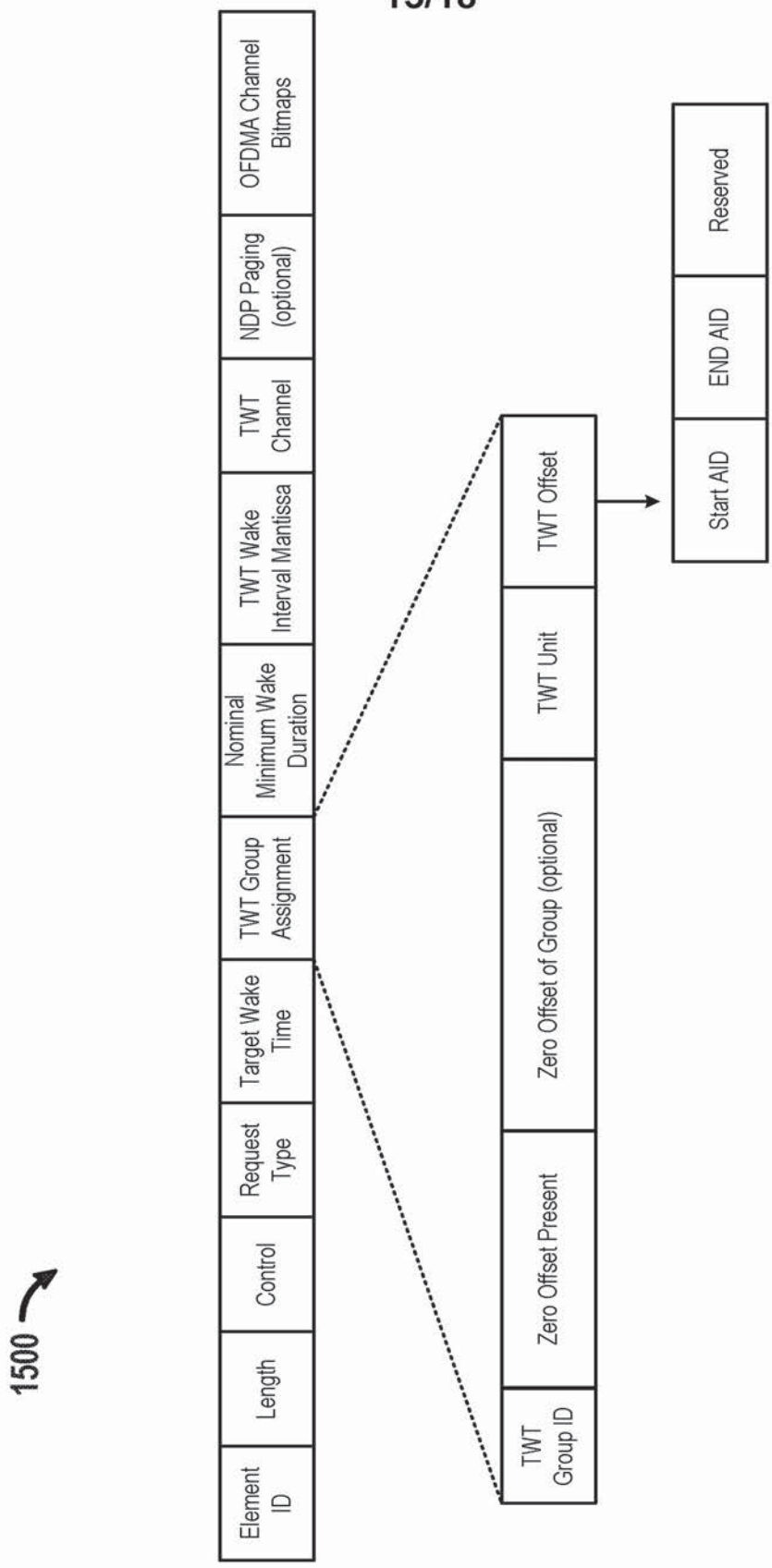

1500
Element ID
Length
Control
Request Type
Target Wake Time
TWT Group Assignment
Nominal Minimum Wake Duration
TWT Wake Interval Mantissa
TWT Channel
NDP Paging (optional)
OFDMA Channel Bitmaps
TWT Group ID
Zero Offset Present
Zero Offset of Group (optional)
TWT Unit
TWT Offset
Start AID
END AID
Reserved

FIG. 15

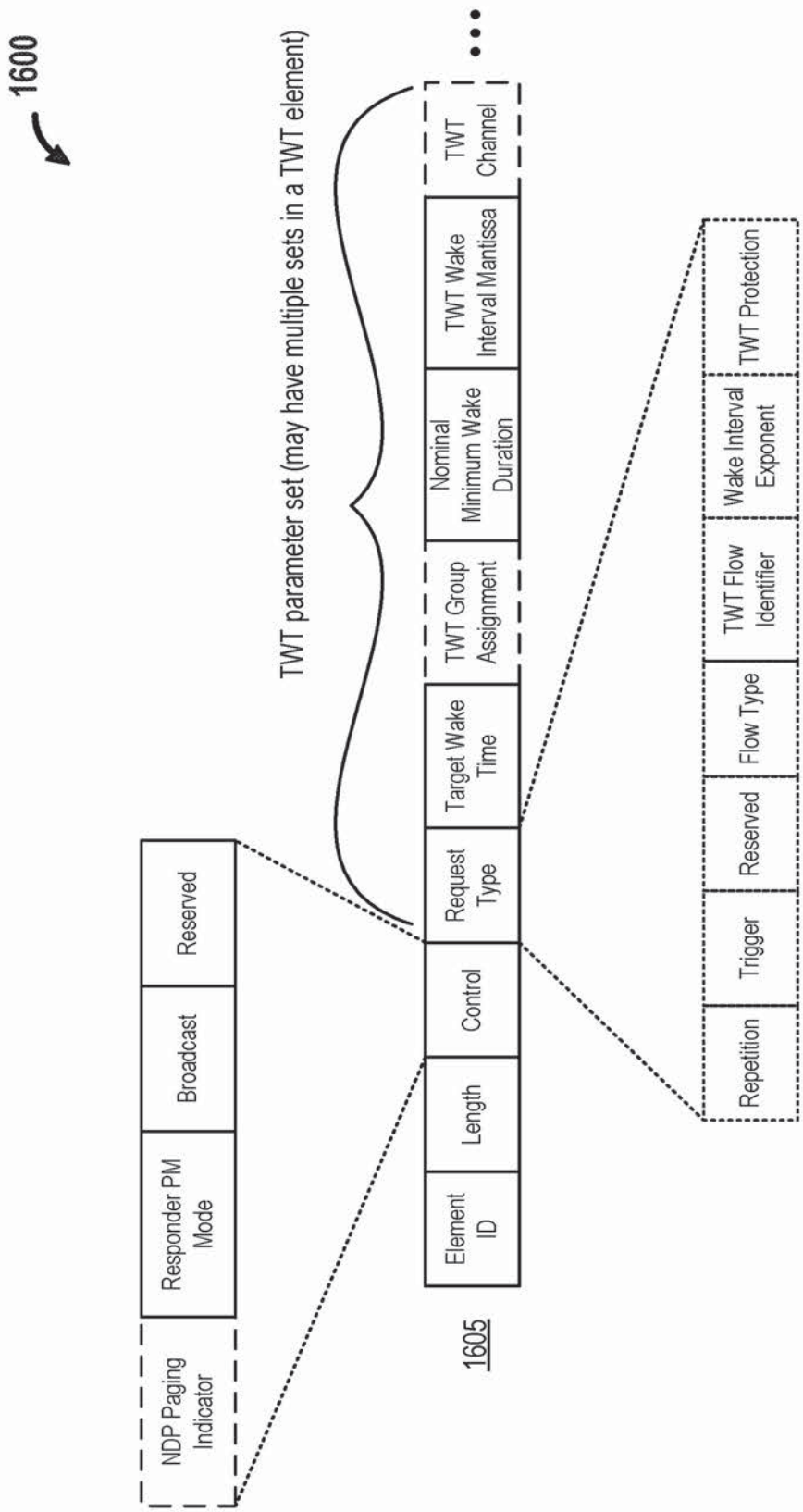

1600
TWT parameter set (may have multiple sets in a TWT element)
Element ID
Length
Control
Request Type
Target Wake Time
TWT Group Assignment
Nominal Minimum Wake Duration
TWT Wake Interval Mantissa
TWT Channel
1605
NDP Paging Indicator
Responder PM Mode
Broadcast
Reserved
Repetition
Trigger
Reserved
Flow Type
TWT Flow Identifier
Wake Interval Exponent
TWT Protection

FIG. 16

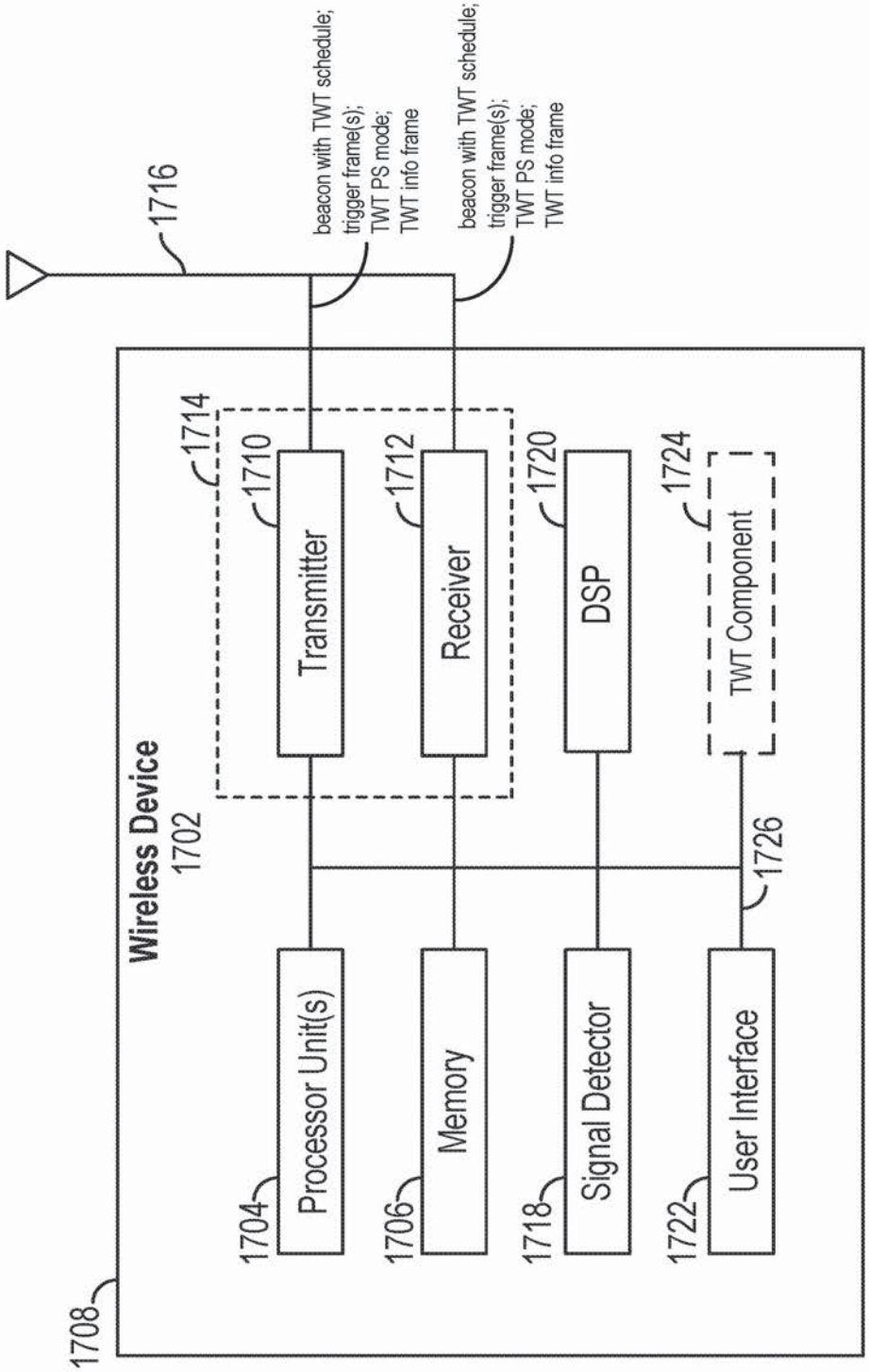

1716
beacon with TWT schedule; trigger frame(s); TWT PS mode; TWT info frame
beacon with TWT schedule; trigger frame(s); TWT PS mode; TWT info frame
Wireless Device
1702
1714
1710
Transmitter
1712
Receiver
1720
DSP
1724
TWT Component
1726
1704
Processor Unit(s)
1706
Memory
1718
Signal Detector
1722
User Interface
1708

FIG. 17

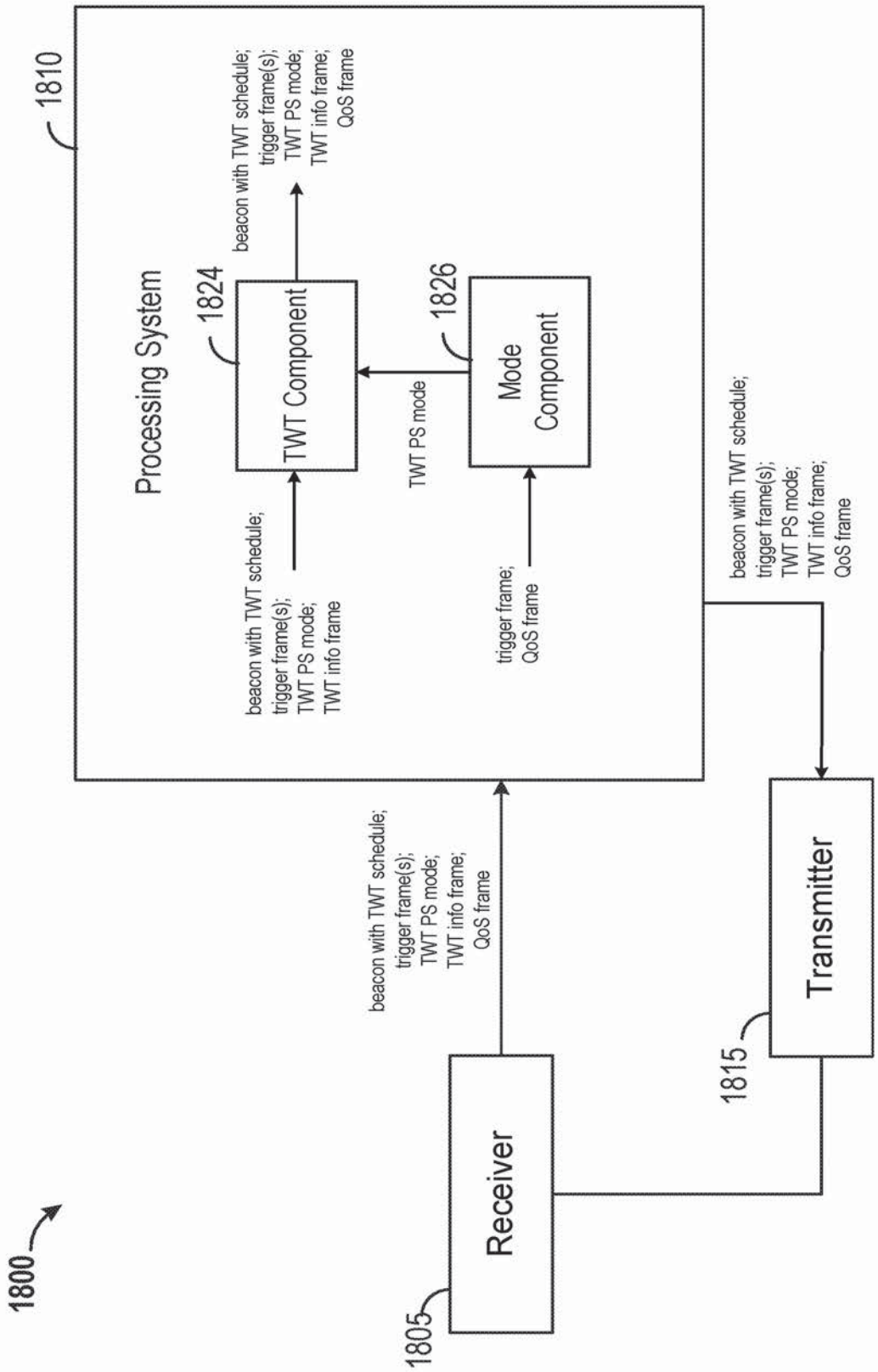

1800
1805
Receiver
1815
Transmitter
1810
Processing System
1824
TWT Component
1826
Mode Component
beacon with TWT schedule; trigger frame(s); TWT PS mode; TWT info frame; QoS frame
beacon with TWT schedule; trigger frame(s); TWT PS mode; TWT info frame
trigger frame; QoS frame
TWT PS mode
beacon with TWT schedule; trigger frame(s); TWT PS mode; TWT info frame; QoS frame
beacon with TWT schedule; trigger frame(s); TWT PS mode; TWT info frame; QoS frame

FIG. 18

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/015465

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W52/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MINYOUNG PARK (INTEL CORP): "Proposed TGah Draft Amendment ; 11-13-0500-00-OOah-proposed-tgah-draft-amendment" , IEEE SA MENTOR; 11-13-0500-00-OOAH-PROPOSED-TGAH-DRAFT-AMENDMENT, IEEE-SA MENTOR, PISCATAWAY, NJ USA, vol . 802.11ah , 10 May 2013 (2013-05-10) , pages 1-330, XP068054010, [retrieved on 2013-05-10] page 138, paragraph 9.32f - page 149, paragraph 9.32k page 163, paragraph 9.32p - page 176, paragraph 10.43d ----- -/- ·	1-56

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" documentwhich may throw doubts on priority claim(s) orwhich is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 March 2016	08/04/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Niederholz, JLirgen

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MATTHEW FISCHER (BROADCOM): "LB200-clause-9_41 ; 11-14-0396-03-00ah-lb200-clause-9-41\ IEEE DRAFT; 11-14-0396-03-00AH-LB200-CLAUSE -9-41, IEEE-SA MENTOR, PISCATAWAY, NJ USA, vol . 802.11ah, no. 3 , 20 March 2014 (2014-03-20), pages 1-43, XP068069075, [retrieved on 2014-03-20] page 30, paragraph 9.41 - page 40, paragraph 10.1.2	1-56
A	US 2014/112229 A1 (MERLIN SIMONE [US] ET AL) 24 April 2014 (2014-04-24) the whole document	1-56
A	US 2014/112226 A1 (JAFARIAN AMIN [US] ET AL) 24 April 2014 (2014-04-24) the whole document	1-56

1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2016/015465

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 2014112229 A1	24-04-2014	CN	104737597 A	24-06-2015
		EP	2912897 A1	02-09-2015
		JP	2015532571 A	09-11-2015
		US	2014112229 A1	24-04-2014
		WO	2014066652 A1	01-05-2014
US 2014112226 A1	24-04-2014	CN	104756560 A	01-07-2015
		EP	2912894 A1	02-09-2015
		JP	2016500985 A	14-01-2016
		KR	20150074148 A	01-07-2015
		US	2014112226 A1	24-04-2014
		WO	2014066046 A1	01-05-2014

Form PCT/ISA/210 (patent family annex) (April 2005)

FORM-2

THE PATENT ACT,1970
(39 OF 1970)
AND
THE PATENT RULES, 2003
(As Amended)

COMPLETE SPECIFICATION
(See section 10;rule 13)

"METHODS AND APPARATUS FOR SELECTING ENHANCED DISTRIBUTED CHANNEL ACCESS PARAMETERS FOR DIFFERENT STATIONS"

QUALCOMM Incorporated, a corporation organized and existing under the laws of USA of ATTN: International IP Administration, 5775 Morehouse Drive, San Diego, California 92121-1714, USA.

The following specification particularly describes the invention and the manner in which it is to be performed:

METHODS AND APPARATUS FOR SELECTING ENHANCED DISTRIBUTED CHANNEL ACCESS PARAMETERS FOR DIFFERENT STATIONS

BACKGROUND

Field

[0001] The present application relates generally to wireless communications, and more specifically to methods and apparatuses for selecting enhanced distributed channel access (EDCA) parameters for multi-user (MU) transmissions.

Background

[0002] Communications networks are used to exchange messages among devices. Wireless networks are often preferred when the network elements are mobile and thus have dynamic connectivity needs, or if the network architecture is formed in an ad hoc, rather than fixed, topology. The devices in a wireless network may transmit/receive information based on channel access protocols such as enhanced distributed channel access (EDCA). EDCA defines separate data traffic access categories, which may include best effort, background, video and voice over wireless local access network (WLAN) (VoWLAN). For example, data traffic associated with transmission or reception of emails may be assigned a low priority class, and VoWLAN may be assigned a high priority class. Utilizing EDCA, high-priority data traffic has more opportunity of being sent than a low-priority data traffic because a station with high priority data traffic waits for less time before sending such a data packet, on average, than a station with low priority data traffic.

[0003] Wireless networks are often preferred when the network elements are mobile and thus have dynamic connectivity needs, or if the network architecture is formed in an ad hoc, rather than fixed, topology. Wireless networks employ intangible physical media in an unguided propagation mode using electromagnetic waves in the radio, microwave, infra-red, optical, etc. frequency bands. Wireless networks advantageously facilitate user mobility and rapid field deployment when compared to fixed wired networks.

[0004] In order to address the issue of increasing bandwidth requirements that are demanded for wireless communications systems, different schemes are being developed to allow multiple user terminals (UTs) to communicate with a single access point by sharing the channel resources while achieving high data throughputs. With limited

communication resources, it is desirable to reduce the amount of traffic passing between the access point and the multiple terminals. For example, when multiple terminals send uplink communications to the access point, it is desirable to minimize the amount of traffic to complete the uplink of all transmissions. Thus, there is a need for an improved protocol for uplink transmissions from multiple terminals.

SUMMARY

[0005] The systems, methods, and devices of the invention each have several aspects, no single one of which is solely responsible for its desirable attributes. Without limiting the scope of this invention as expressed by the claims which follow, some features will now be discussed briefly. After considering this discussion, and particularly after reading the section entitled "Detailed Description" one will understand how the features of this invention provide advantages that include improved communications between access points and stations in a wireless network.

[0006] One aspect of the disclosure provides a method for selecting channel access parameters for communication in a network, the method comprising selecting, at a first wireless device, an enhanced distributed channel access (EDCA) parameter for communication with a second wireless device, wherein selecting the EDCA parameter is based on a capability of the first wireless device to receive scheduled uplink transmissions, and a capability of the second wireless device to transmit multi-user uplink transmissions.

[0007] For some embodiments, the method may include transmitting an indication of the selection of the EDCA parameter to the second wireless device. For some embodiments, the first wireless device is one of an access point and a station, and the second wireless device is the other one of the access point and the station. For some embodiments, selecting the EDCA parameter is based on a previous transmission from the second wireless device to the first wireless device. For some embodiments, selecting the EDCA parameter is based on receiving an immediate response to the indication transmitted to the second wireless device. For some embodiments, selecting a second EDCA parameter for communication with the second wireless device is based on a time elapsed since receiving an immediate response to the indication transmitted to the second wireless device. For some embodiments, the method may include generating an information element, the information element comprising a variable length of bits,

wherein the variable length of bits is based on at least one of a type of signal and a service provider. For some embodiments, selecting the EDCA parameter further comprises selecting the EDCA parameter based on a type of the second wireless device. For some embodiments, the method may include classifying the second wireless device into a subset of wireless devices, the subset of wireless devices being one of a plurality of subsets of wireless devices, wherein the classification is based on a type of the second wireless device and a multi-user uplink capability of the second wireless device. For some embodiments, the method may include selecting, at the first wireless device, the EDCA parameter for communication with the second wireless device based on the subset of wireless devices. For some embodiments, the EDCA parameter comprises at least one of a minimum contention window (CWmin), a maximum contention window (CWmax), a transmit opportunity (TXOP), a transmission opportunity limit (TXOP limit), and an arbitration inter frame space (AIFS). For some embodiments, the first wireless device appends one or more rules for the first wireless device to the EDCA parameter. For some embodiments, the second wireless device is triggered by the first wireless device via the multi-user uplink transmissions to send a single-user uplink transmission. For some embodiments, the second wireless device operates in at least one of a non-high throughput mode and a very high throughput mode. For some embodiments, the method may include advertising, by the first wireless device, the EDCA parameter via an information element, wherein the information element includes at least one of an element identification field, a length field, another information field, and an extension field.

[0008] Another aspect of the disclosure is an apparatus for wireless communication, comprising a processing system configured to select, at a first wireless device, an enhanced distributed channel access (EDCA) parameter for communication with a second wireless device, wherein selecting the EDCA parameter is based on a capability of the first wireless device to receive scheduled uplink transmissions uplink transmissions, and a capability of the second wireless device to transmit multi-user uplink transmissions.

[0009] For some embodiments, the apparatus may include a transmitter configured to transmit an indication of the selection of the EDCA parameter to the second wireless device. In some embodiments, wherein the processing system is further configured to select the EDCA parameter based on a capability of the first wireless device to receive

scheduled uplink transmissions uplink transmissions and a capability of the second wireless device to transmit multi-user uplink transmissions. In some embodiments, selecting the EDCA parameter further comprises selecting the EDCA parameter based on a type of the second wireless device. In some embodiments, the processing system is further configured to classify the second wireless device into a subset of wireless devices, the subset of wireless devices being one of a plurality of subsets of wireless devices, wherein the classification is based on a type of the second wireless device and a multi-user uplink capability of the second wireless device. In some embodiments, the EDCA parameter is selected based on the subset of wireless devices. In some embodiments, the EDCA parameter comprises at least one of a minimum contention window (CWmin), a maximum contention window (CWmax), a transmit opportunity (TXOP), a transmission opportunity limit (TXOP limit), and an arbitration inter frame space (AIFS). In some embodiments, the first wireless device appends one or more rules for the first wireless device to the EDCA parameter. In some embodiments, the second wireless device is triggered by the first wireless device via the multi-user uplink transmissions to send a single-user uplink transmission. In some embodiments, the second wireless device operates in at least one of a non-high throughput mode and a very high throughput mode. In some embodiments, the processor system may advertise, by the first wireless device, the EDCA parameter via an information element, wherein the information element includes at least one of an element identification field, a length field, another information field, and an extension field.

[0010] Another aspect of the disclosure is a non-transitory computer-readable medium comprising code that, when executed, causes an apparatus to select, at a first wireless device, an enhanced distributed channel access (EDCA) parameter for communication with a second wireless device, wherein selecting the EDCA parameter is based on a capability of the first wireless device to receive scheduled uplink transmissions, and a capability of the second wireless device to transmit multi-user uplink transmissions.

[0011] For some embodiments, the non-transitory computer-readable medium comprising code that, when executed, causes an apparatus to select, at a first wireless device, an enhanced distributed channel access (EDCA) parameter for communication with a second wireless device, wherein selecting the EDCA parameter is based on a capability of the first wireless device to receive scheduled uplink transmissions, and a

capability of the second wireless device to transmit multi-user uplink transmissions. For some embodiments, the non-transitory computer-readable medium comprising code that, when executed, causes the apparatus to advertise, by the first wireless device, the EDCA parameter via an information element, wherein the information element includes at least one of an element identification field, a length field, another information field, and an extension field. For some embodiments, the non-transitory computer-readable medium comprising code that, when executed, causes the apparatus to transmit an indication of the selection of the EDCA parameter to the second wireless device. For some embodiments, the non-transitory computer-readable medium comprising code that, when executed, causes the apparatus to classify the second wireless device into a subset of wireless devices, the subset of wireless devices being one of a plurality of subsets of wireless devices, wherein the classification is based on a type of the second wireless device and a multi-user uplink capability of the second wireless device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 illustrates an example of a wireless communication system in which aspects of the present disclosure may be employed.

[0013] FIG. 2 illustrates various components that may be utilized in a wireless device that may be employed within the wireless communication system of FIG. 1.

[0014] FIG. 3 illustrates an exemplary implementation of an information element.

[0015] FIG. 4 illustrates another exemplary implementation of an EDCA parameter set information element.

[0016] FIG. 5 shows a flow chart of an exemplary method of wireless communication in a wireless communication system.

DETAILED DESCRIPTION

[0017] Various aspects of the novel systems, apparatuses, and methods are described more fully hereinafter with reference to the accompanying drawings. This disclosure may, however, be embodied in many different forms and should not be construed as limited to any specific structure or function presented throughout this disclosure. Rather, these aspects are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Based on the teachings herein one skilled in the art should appreciate that the scope

of the disclosure is intended to cover any aspect of the novel systems, apparatuses, and methods disclosed herein, whether implemented independently of, or combined with, any other aspect of the invention. For example, an apparatus can be implemented or a method can be practiced using any number of the aspects set forth herein. In addition, the scope of the invention is intended to cover such an apparatus or method which is practiced using other structure, functionality, or structure and functionality in addition to or other than the various aspects of the invention set forth herein. It should be understood that any aspect disclosed herein can be embodied by one or more elements of a claim.

[0018] Although particular aspects are described herein, many variations and permutations of these aspects fall within the scope of the disclosure. Although some benefits and advantages of the preferred aspects are mentioned, the scope of the disclosure is not intended to be limited to particular benefits, uses, or objectives. Rather, aspects of the disclosure are intended to be broadly applicable to different wireless technologies, system configurations, networks, and transmission protocols, some of which are illustrated by way of example in the figures and in the following description of the preferred aspects. The detailed description and drawings are merely illustrative of the disclosure rather than limiting, the scope of the disclosure being defined by the appended claims and equivalents thereof.

[0019] Popular wireless network technologies may include various types of wireless local area networks (WLANs). A WLAN can be used to interconnect nearby devices together, employing widely used networking protocols. The various aspects described herein may apply to any communication standard, such as a wireless protocol.

[0020] In some aspects, wireless signals can be transmitted according to a high-efficiency 802.11 protocol using orthogonal frequency-division multiplexing (OFDM), direct–sequence spread spectrum (DSSS) communications, a combination of OFDM and DSSS communications, or other schemes. In some aspects, the high-efficiency 802.11 protocol may comprise the IEEE 802.11ax protocol or future protocols. Implementations of the high-efficiency 802.11 protocol can be used for Internet access, sensors, metering, smart grid networks, or other wireless applications. Advantageously, aspects of certain devices implementing the high-efficiency 802.11 protocol using the techniques disclosed herein may include allowing for increased peer-to-peer services (for example, Miracast, WiFi Direct Services, Social WiFi, etc.) in the same area,

supporting increased per-user minimum throughput requirements, supporting more users, providing improved outdoor coverage and robustness, and/or consuming less power than devices implementing other wireless protocols.

[0021] In some implementations, a WLAN includes various devices which are the components that access the wireless network. For example, there can be two types of devices: access points ("APs") and clients (also referred to as stations, or "STAs"). In general, an AP may serve as a hub or base station for the WLAN and an STA serves as a user of the WLAN. For example, an STA can be a laptop computer, a personal digital assistant (PDA), a mobile phone, etc. In an example, an STA connects to an AP via a WiFi (for example, IEEE 802.11 protocol) compliant wireless link to obtain general connectivity to the Internet or to other wide area networks. In some implementations an STA may also be used as an AP.

[0022] An access point ("AP") may also comprise, be implemented as, or known as a NodeB, Radio Network Controller ("RNC"), eNodeB, Base Station Controller ("BSC"), Base Transceiver Station ("BTS"), Base Station ("BS"), Transceiver Function ("TF"), Radio Router, Radio Transceiver, or some other terminology.

[0023] A station "STA" may also comprise, be implemented as, or known as an access terminal ("AT"), a subscriber station, a subscriber unit, a mobile station, a remote station, a remote terminal, a user terminal, a user agent, a user device, user equipment, or some other terminology. In some implementations an access terminal may comprise a cellular telephone, a cordless telephone, a Session Initiation Protocol ("SIP") phone, a wireless local loop ("WLL") station, a personal digital assistant ("PDA"), a handheld device having wireless connection capability, or some other suitable processing device connected to a wireless modem. Accordingly, one or more aspects taught herein can be incorporated into a phone (for example, a cellular phone or smartphone), a computer (for example, a laptop), a portable communication device, a headset, a portable computing device (for example, a personal data assistant), an entertainment device (for example, a music or video device, or a satellite radio), a gaming device or system, a global positioning system device, or any other suitable device that is configured to communicate via a wireless medium.

[0024] As discussed above, certain of the devices described herein may implement a high-efficiency 802.11 standard, for example. Such devices, whether used as an STA or AP or other device, can be used for smart metering or in a smart grid network. Such

devices may provide sensor applications or be used in home automation. The devices may instead or in addition be used in a healthcare context, for example for personal healthcare. They may also be used for surveillance, to enable extended-range Internet connectivity (for example, for use with hotspots), or to implement machine-to-machine communications.

[0025] FIG. 1 shows an exemplary wireless communication system 100 in which aspects of the present disclosure can be employed. The wireless communication system 100 may operate pursuant to a wireless standard, for example a high-efficiency 802.11 standard. The wireless communication system 100 may include an AP 104, which communicates with STAs 106a-d.

[0026] A variety of processes and methods can be used for transmissions in the wireless communication system 100 between the AP 104 and the STAs 106. For example, signals can be sent and received between the AP 104 and the STAs 106 in accordance with OFDM/OFDMA or multi-user multiple input multiple output (MU-MIMO) techniques. If this is the case, the wireless communication system 100 can be referred to as an OFDM/OFDMA or an MU-MIMO system. Alternatively, signals can be sent and received between the AP 104 and the STAs 106 in accordance with code division multiple access (CDMA) techniques. If this is the case, the wireless communication system 100 can be referred to as a CDMA system.

[0027] A communication link that facilitates transmission from the AP 104 to one or more of the STAs 106 can be referred to as a downlink (DL) 108, and a communication link that facilitates transmission from one or more of the STAs 106 to the AP 104 can be referred to as an uplink (UL) 110. Alternatively, a downlink 108 can be referred to as a forward link or a forward channel, and an uplink 110 can be referred to as a reverse link or a reverse channel.

[0028] The AP 104 may act as a base station and provide wireless communication coverage in a basic service area (BSA) 102. The AP 104 along with the STAs 106 associated with the AP 104 and that use the AP 104 for communication can be referred to as a basic service set (BSS). It should be noted that the wireless communication system 100 may not have a central AP 104, but rather may function as a peer-to-peer network between the STAs 106. Accordingly, the functions of the AP 104 described herein may alternatively be performed by one or more of the STAs 106.

[0029] In some aspects, a STA 106 can be required to associate with the AP 104 in order to send communications to and/or receive communications from the AP 104. In one aspect, information for associating is included in a broadcast by the AP 104. To receive such a broadcast, the STA 106 may, for example, perform a broad coverage search over a coverage region. A search may also be performed by the STA 106 by sweeping a coverage region in a lighthouse fashion, for example. After receiving the information for associating, the STA 106 may transmit a reference signal, such as an association probe or request, to the AP 104. In some aspects, the AP 104 may use backhaul services, for example, to communicate with a larger network, such as the Internet or a public switched telephone network (PSTN).

[0030] In an embodiment, the AP 104 includes an AP high-efficiency wireless component (HEWC) 154. The AP HEWC 154 may perform some or all of the operations described herein to enable communications between the AP 104 and the STAs 106 using the high-efficiency 802.11 protocol. The functionality of some implementations of the AP HEWC 154 is described in greater detail below with respect to FIGS. 2, 3, and 4.

[0031] Alternatively or in addition, the STAs 106 may include a STA HEWC 156. The STA HEWC 156 may perform some or all of the operations described herein to enable communications between the STAs 106 and the AP 104 using the high-efficiency 802.11 protocol.

[0032] Generally, wireless networks that use a regular 802.11 protocol (for example, 802.11ax, 802.11ah, 802.11ac, 802.11a, 802.11b, 802.11g, 802.11n, etc.) operate under a carrier sense multiple access (CSMA) mechanism for medium access. According to CSMA, devices sense the medium and only transmit when the medium is sensed to be idle. Thus, if the AP104 and/or STAs 106a-d are operating according to the CSMA mechanism and a device in the BSA 102 (for example, the AP 104) is transmitting data, then in some aspects APs and/or STAs outside of the BSA 102 may not transmit over the medium even though they are part of a different BSA.

[0033] The use of the CSMA mechanism then creates inefficiencies because some APs or STAs outside of a BSA can be able to transmit data without interfering with a transmission made by an AP or STA in the BSA. As the number of active wireless devices continues to grow, the inefficiencies can begin to significantly affect network latency and throughput. For example, significant network latency issues may appear in

apartment buildings, in which each apartment unit may include an access point and associated stations. In fact, each apartment unit may include multiple access points, as a resident may own a wireless router, a video game console with wireless media center capabilities, a television with wireless media center capabilities, a cell phone that can act like a personal hot-spot, and/or the like. Correcting the inefficiencies of the CSMA mechanism may then be vital to avoid latency and throughput issues and overall user dissatisfaction.

[0034] Such latency and throughput issues may not be confined to residential areas. For example, multiple access points can be located in airports, subway stations, and/or other densely-populated public spaces. Currently, WiFi access can be offered in these public spaces, but for a fee. If the inefficiencies created by the CSMA mechanism are not corrected, then operators of the wireless networks may lose customers as the fees and lower quality of service begin to outweigh any benefits.

[0035] Accordingly, the high-efficiency 802.11 protocol described herein may allow for devices to operate under a modified mechanism that minimizes these inefficiencies and increases network throughput. Such a mechanism is described below with respect to FIGs. 3-5. Additional aspects of the high-efficiency 802.11 protocol are described below with respect to FIGS. 3-5.

[0036] FIG. 2 illustrates various components that may be utilized in a wireless device 202 that may be employed within the wireless communication system 100. The wireless device 202 is an example of a device that may be configured to implement various aspects described herein. For example, the wireless device 202 may comprise the AP 104 or any one of the wireless devices 106a-106d.

[0037] The wireless device 202 may include a processor 204 which controls operation of the wireless device 202. The processor 204 may also be referred to as a central processing unit (CPU). Memory 206, which may include both read-only memory (ROM) and random access memory (RAM), provides instructions and data to the processor 204. A portion of the memory 206 may also include non-volatile random access memory (NVRAM). The processor 204 typically performs logical and arithmetic operations based on program instructions stored within the memory 206. The instructions in the memory 206 may be executable to implement the methods described herein.

[0038] The processor 204 may comprise or be a component of a processing system implemented with one or more processors. The one or more processors may be implemented with any combination of general-purpose microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate array (FPGAs), programmable logic devices (PLDs), controllers, state machines, gated logic, discrete hardware components, dedicated hardware finite state machines, or any other suitable entities that can perform calculations or other manipulations of information.

[0039] The processing system may also include non-transitory machine-readable media for storing software. Software shall be construed broadly to mean any type of instructions, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. Instructions may include code (e.g., in source code format, binary code format, executable code format, or any other suitable format of code). The instructions, when executed by the one or more processors, cause the processing system to perform the various functions described herein.

[0040] The wireless device 202 may also include a housing 208 that may include a transmitter 210 and a receiver 212 to allow transmission and reception of data between the wireless device 202 and a remote location. The transmitter 210 and receiver 212 may be combined into a transceiver 214. An antenna 216 may be attached to the housing 208 and electrically coupled to the transceiver 214. The wireless device 202 may also include (not shown) multiple transmitters, multiple receivers, multiple transceivers, and/or multiple antennas, which may be utilized during MIMO communications, for example.

[0041] The wireless device 202 may also include a signal detector 218 that may be used in an effort to detect and quantify the level of signals received by the transceiver 214. The signal detector 218 may detect such signals as total energy, energy per subcarrier per symbol, power spectral density and other signals. The wireless device 202 may also include a digital signal processor (DSP) 220 for use in processing signals. The DSP 220 may be configured to generate a data unit for transmission. In some aspects, the data unit may comprise a physical layer convergence procedure (PLCP) protocol data unit (PPDU). In some aspects, the PPDU is referred to as a packet.

[0042] The wireless device 202 may further comprise a user interface 222 in some aspects. The user interface 222 may comprise a keypad, a microphone, a speaker, and/or a display. The user interface 222 may include any element or component that

conveys information to a user of the wireless device 202 and/or receives input from the user.

[0043] The wireless devices 202 may further comprise a high-efficiency wireless (HEW) component 250 in some aspects. The HEW component 250 may comprise the AP HEWC 154 and/or the STA HEWC 156. As described herein, the HEW component 250 may enable APs and/or STAs to use a modified mechanism that minimizes the inefficiencies of the CSMA mechanism (for example, enables concurrent communications over the medium in situations in which interference would not occur). In some aspects, the AP HEWC 154 may select an EDCA parameter based on the type of STA and/or based on the UL-MU capabilities of the STA. For example, the AP HEWC 154 may a select one or more EDCA parameters for a first subset of STAs of a plurality of STAs that are capable of transmitting UL-MU transmissions (e.g., STAs operating under the 802.11ax standard) and may select a different set of one or more EDCA parameters for a second subset of STAs of a plurality of STAs that are not capable of transmitting UL-MU transmissions (e.g., STAs operating under the 802.11ac or earlier standard). In some embodiments, the first subset and second subset may comprise one or more STAs.

[0044] The various components of the wireless device 202 may be coupled together by a bus system 226. The bus system 226 may include a data bus, for example, as well as a power bus, a control signal bus, and a status signal bus in addition to the data bus. Those of skill in the art will appreciate the components of the wireless device 202 may be coupled together or accept or provide inputs to each other using some other mechanism.

[0045] Although a number of separate components are illustrated in FIG. 2, those of skill in the art will recognize that one or more of the components may be combined or commonly implemented. For example, the processor 204 may be used to implement not only the functionality described above with respect to the processor 204, but also to implement the functionality described above with respect to the signal detector 218 and/or the DSP 220. Further, each of the components illustrated in FIG. 2 may be implemented using a plurality of separate elements.

[0046] In a wireless network, channel access parameters can be defined to control access to a transmission medium (e.g., a wireless network) by devices communicating via the wireless network. A transmission medium can also be termed as a transmission

channel. Examples of channel access parameters can include (but are not limited to) parameters described as part of the enhanced distributed channel access (EDCA) parameters in the 802.11 industry standard (e.g., 802.11ax). Further examples of channel access parameters can include (but are not limited to) minimum contention window (CWmin), maximum contention window (CWmax), transmit opportunity (TXOP), transmission opportunity limit (TXOP limit), and arbitration inter frame space (AIFS), which may also be part of the EDCA parameters.

[0047] Certain aspects of the present disclosure support transmitting an uplink (UL) signal or packet 110 from multiple STAs 106 to the AP 104 or other device. In some embodiments, the UL signal 110 may be transmitted using multi-user MIMO (MU-MIMO). In some embodiments, the UL signal 110 may be transmitted UL- OFDMA. Alternatively, the UL signal 110 may be transmitted in a multi-carrier FDMA (MC-FDMA) or similar FDMA system (e.g., OFDMA). In some aspects, the MU-MIMO/OFDMA and MC-FDMA transmissions comprise concurrent UL transmissions from multiple STAs 106 to the AP 104 may be referred to as more generally, UL-MU communications or transmissions. In some embodiments, the AP 104 may define EDCA parameters to facilitate UL-MU transmissions. The EDCA parameters may be selected and transmitted from the AP 104 during association/re-association (e.g., as data in an association/re-association response message) or included in a beacon frame. In other aspects, the AP 104 may choose to select the EDCA parameters for MU transmissions, and not notify the STAs. In one embodiment the EDCA parameters may be defined in an IEEE 802.11 standard (e.g., 802.11ax). In another embodiment, the EDCA parameter may be enhanced from that defined in an IEEE 802.11 standard by appending one or more rules for an AP 104, a subset of STAs 106, or a type of STAs 106.

[0048] The number of wireless devices 202 within the wireless communication system 100 and contending for the same wireless medium can impact the performance of the CSMA mechanism. As the number of devices operating within the network increases, the CSMA mechanism may not be able to adequately support transmissions for a dense network. In some aspects, UL-MU-MIMO or UL-OFDMA transmissions sent simultaneously from multiple STAs 106 to the AP 104 may create efficiencies in wireless communication. However, in some aspects, UL-MU-MIMO or UL-OFDMA transmissions may also contend with CSMA based UL single user (SU) transmissions. When there are a large number of UL-SU transmissions or accesses of the medium, the

AP 104 will need to compete against multiple UL-SU transmissions, which could lead to potential unfairness, decreased throughput, reduced access (and starvation in some cases) to UL-MU transmissions. For example, referring to FIG. 1, in some aspects, STAs 106a and 106b may transmit UL-SU signals 110a and 110b and STAs 106c and 106d may transmit UL-MU signals 110c and 110d. Each of the STAs 106a-d contends for channel access to transmit UL signals 110a-d. Such contention may be based on an EDCA parameter and/or an EDCA protocol as specified in an IEEE 802.11 standard (e.g., 802.11ah, or 802.11ac). In some embodiments, the UL-MU signals 110c and 110d (e.g., UL-MU-MIMO or UL-OFDMA transmissions) may be based on a UL-MU trigger frame sent by the AP 104 to the STAs 106c and 106d.

[0049] In some aspects, the STAs 106c and 106d may be unable to transmit the high efficiency (HE) UL-MU signals 110c and 110d for an extended period of time when the AP 104 cannot access the channel/medium due to the UL-SU signals 110a and 110b. Also, it may be unfair for STAs that are not capable of transmitting UL-MU transmissions (e.g., legacy STAs) if the same EDCA parameters are used for both STAs capable and not capable of transmitting UL-MU transmissions, since only the STAs capable of transmitting UL-MU transmissions (e.g., scheduled mode STAs) benefit from UL-MU transmissions.

[0050] In some embodiments, the AP 104 may limit UL SU transmission by adjusting EDCA parameters for STAs capable of and willing for transmitting UL MU transmissions. The AP 104 may classify the STAs based on their ability to receive and/or transmit scheduled uplink transmissions, or UL MU transmissions. For example, the AP 104 may classify an STA 106 whose UL frames can be both triggered by the AP 104 (e.g., via MU-MIMO, UL OFDMA or other UL-MU transmission) and sent in legacy way into one subset, while classifying an STA 106 whose UL frames can only be sent in a legacy way, into a second subset. However, problems may still exist because the adjusted EDCA parameters broadcasted in existing EDCA parameter set IE in a beacon may affect STAs not capable of or not willing for transmitting UL MU transmissions, since they cannot identify that the carried EDCA parameters are not intended for them. In some aspects, a STA 106 whose UL frames can be both triggered by the AP 104 (e.g., via MU-MIMO, UL OFDMA or other UL-MU transmission) and sent in legacy way (e.g., UL SU frames based on CSMA) may be referred to as a scheduled mode STA. STAs 106 whose UL frames can only be sent in SU CSMA based

transmissions may be referred to as legacy mode STAs. For example, legacy mode STAs may operate in non-high throughput (HT), HT, very high throughput (VHT) modes, which do not support triggered (e.g., MU) UL transmissions such as those defined in the 802.11ax standard. In some aspects, 802.11ax STAs can operate in scheduled mode or legacy mode depending on their capability and/or willingness. In some aspects, non-802.11ax STAs can operate only in legacy mode. In some aspects, the AP 104 may select the EDCA based on whether the AP 104 is capable of receiving scheduled uplink transmissions, or UL MU transmissions, from the STAs 106.

[0051] Embodiments described herein relate to selecting a different EDCA protocol and/or parameters for a first subset of STAs (e.g., scheduled mode STAs) than for a second subset of STAs (e.g., legacy mode STAs). In some aspects, the different EDCA protocol and/or parameter may comprise setting shorter transmission opportunity (TXOP) limits and/or a larger minimum contention window (CWmin) for scheduled mode STAs than those set for legacy mode STAs. Embodiments described herein also relate to options for signaling EDCA parameters for the first subset of STAs (e.g., scheduled mode STAs) vs. the second subset of STAs (e.g., legacy mode STAs).

[0052] In some embodiments, the AP 104 may advertise the EDCA parameter (e.g., CW) for the first subset of STAs (e.g., scheduled mode STAs) in a variety of ways. In some aspects, the AP 104 may transmit an information element (IE), different from an existing EDCA parameter set IE to carry scheduled mode EDCA parameters.

[0053] FIG. 3 illustrates an exemplary implementation of an information element (IE) 300 that may be employed within the wireless communication system 100 of FIG. 1. In various embodiments, any device described herein, or another compatible device, may transmit the information element 300 such as, for example, the AP 104 (FIG. 1), a STA 106a–106d (FIG. 1), and/or the wireless device 202 (FIG. 2). One or more messages in the wireless communication system 100 may include the information element 300 such as, for example, downlink communication 108 and uplink communication 110.

[0054] In the illustrated embodiment, the information element 300 includes an element identification (ID) field 302, a length field 304, and another information field 310. The information element 300 may include additional fields, and fields may be rearranged, removed, and/or resized.

[0055] In some aspects, the element identifier (ID) field 302 identifies a type of element. The element ID field 302 shown may be one octet long. In some

implementations, the element identifier field 302 may be two, five, or twelve octets long. In some implementations, the element identifier field 302 may be of variable length, such as varying length from signal to signal, or type of signal, and/or as between service providers and the types of service providers.

[0056] In some embodiments, the IE 300 may comprise an IE with a unique value in the element ID field 302 (e.g., an IE different from existing IEs). This newly defined IE may provide the scheduled mode EDCA parameter set to the first subset of STAs (e.g., scheduled mode STAs). In other aspects, the IE 300 may have a non-unique element ID field 302 but may comprise an IE extension field (not shown), and the combination of the element ID field 302 and the IE extension field is unique and the IE 300 can be identified as a newly defined or unique IE for carrying the scheduled mode EDCA parameter set to the first subset of STAs (e.g., scheduled mode STAs). For example, the element ID field 302 may have a value of 255, which can be shared by many IEs, while the IE extension field may have a value of 1. The combination of the 255 value in the element ID field 302 and the value of 1 in the IE extension field may be unique to the IE 300 and indicate a unique IE not previously defined. In some aspects, the IE 300 described above may be referred to as a scheduled mode EDCA parameter set IE.

[0057] In other embodiments, the IE 300 may reuse an existing IE other than existing EDCA parameter set IE (e.g., HE operation IE) that includes one or more new fields (not shown) to indicate that the existing IE carries EDCA parameters (e.g., scheduled mode EDCA parameters) for the first subset of STAs (e.g., scheduled mode STAs).

[0058] The length field 304 may be used to indicate the length of the information element 300 or the total length of subsequent fields. The length field 304 shown in FIG. 9 may be one octet long. In some implementations, the length field 304 may be two, five, or twelve octets long. In some implementations, the length field 304 may be of variable length, such as varying length from signal to signal, or type of signal, and/or as between service providers and the types of service providers.

[0059] The other information field 310 may be used to indicate other information of the information element 300 other than the element ID or length. In some aspects, the size and number of fields included in the other information field 310 may be based on the value of the element ID field 302 and/or the length field 304. For example, the element ID field 302 may indicate a very high throughput (VHT) information element and the

other information field 310 may include VHT operation information such as channel width and/or channel center frequency.

[0060] In some embodiments, the AP 104 may include the IE 300 in management/action frames, which can be sent in a broadcast/multicast/unicast transmission. In some aspects, the IE 300 described above may be transmitted such that the second subset of STAs (i.e., non-11ax legacy mode STAs) is unable to understand the IE 300 because of the unrecognized unique element ID field 302, unique combination of the element ID field 302 and element ID extension, or one or more fields including the EDCA parameters for the first subset of STAs (e.g., scheduled mode STAs). In some aspects, the first subset of STAs (i.e. scheduled mode STAs) may be able to decode the IE 300 and follow the new EDCA parameters included in the IE 300. In other aspects, the second subset of STAs (i.e. 11ax legacy mode STAs) may decode the IE 300 and determine to ignore the unintended IE 300, and may determine to continue to operate in legacy mode and follow legacy IE EDCA parameters.

[0061] FIG. 4 illustrates an exemplary implementation of an EDCA parameter set information element 400. In some aspects, the AP 104 may transmit the EDCA parameter set element 400 to advertise the EDCA parameter. The EDCA parameter set IE element 400 includes an element identifier (ID) field 302, a length field 304, and an EDCA parameter field 410. In some aspects, the EDCA parameter field 410 indicates an EDCA parameter used for CSMA based SU transmission from scheduled mode STAs. For example, the EDCA parameter field 410 may include an indication of a CW size used for CSMA based SU transmission from scheduled mode STAs.

[0062] In some embodiments, the AP 104 may signal scheduled mode EDCA parameters to the first subset of STAs (e.g., scheduled mode STAs) by transmitting the EDCA parameter set IE 400 in a physical layer convergence procedure (PLCP) protocol data unit (PPDU) that is only decodable by the first subset of STAs. For example, the AP 104 may transmit an EDCA IE in an 802.11ax PPDU to carry the scheduled mode EDCA parameters. The 802.11ax PPDUs can be broadcasted/multicasted/unicasted by the AP 104, and cannot be understood/decoded by the second subset of STAs (e.g., legacy mode STAs). The second subset of STAs (e.g., legacy mode STAs) may then ignore the 802.11ax PPDU and only follow EDCA IEs sent in legacy or non-802.11ax PDDUs.

[0063] In some aspects, the EDCA parameter set IE 400 included in the 802.11ax PPDU may only carry scheduled mode EDCA parameters. In this embodiment, the EDCA parameters should only be used by the first subset of STAs (e.g., scheduled mode STAs). The second subset of STAs (e.g., legacy mode STAs) should ignore it and only follow existing IE in non-11ax PPDU. In other aspects, the EDCA parameter set IE 400 included in the 802.11ax PPDU may signal either scheduled mode or legacy mode EDCA parameters. In this embodiment, an indicator can be added in the EDCA parameter set IE 400 to indicate if it is for scheduled or legacy mode EDCA, e.g. by using a reserved bit in EDCA parameter set IE 400 (not shown).

[0064] In some embodiments, the AP 104 may signal scheduled mode EDCA parameters to the first subset of STAs (e.g., scheduled mode STAs) by transmitting the EDCA parameter set IE 400 in a physical layer convergence procedure (PLCP) protocol data unit (PPDU) that is decodable by both the first subset of STAs (scheduled mode STAs) and the second subset of STAs (e.g., legacy mode STAs). For example, the AP 104 may transmit an EDCA IE in an 802.11ac (or older) PPDU to carry the scheduled mode EDCA parameters. In these implementations, the AP 104 may multicast or unicast the EDCA parameter set IE 400 carrying scheduled mode EDCA parameters only to the first subset of STAs (e.g., scheduled mode STAs). The second subset of STAs (e.g., legacy mode STAs) will not receive the PPDU including the EDCA parameter set IE 400 due to the recipient address. In some aspects, the frame types that are available to unicast or multicast the EDCA parameter set IE 400 may be defined in an 802.11 standard (e.g., 802.11ax).

[0065] In some aspects, the AP 104 may also broadcast the EDCA parameter set IE 400 carrying EDCA parameters for the second subset of STAs (e.g., legacy mode EDCA parameters). In these implementations, it may be desirable for certain methods to prevent EDCA parameters for the first subset of STAs (e.g., scheduled mode STAs) from being overwritten by the legacy mode EDCA parameters included in the EDCA parameter set IE 400. In some aspects, the first subset of STAs (e.g., scheduled mode STAs) may pre-programmed to know that broadcasted EDCA is only for legacy mode STAs (e.g., predefined in the 802.11 standard), and should be ignored by scheduled mode STAs. In other aspects, an indicator may be added in the broadcasted EDCA parameter set IE 400 to tell first subset of STAs (e.g., scheduled mode STAs) if they

should ignore the EDCA parameter set IE 400 or not. For example, the indicator may comprise one or more reserved bits (not shown) in the EDCA parameter set IE 400.

[0066] In some embodiments, a STA 106 may derive scheduled mode EDCA parameters based on legacy mode EDCA parameters. For example, a scheduled mode EDCA parameter (e.g., CWmin) may be a defined offset from the value of the EDCA parameter (CWmin) in legacy mode. In some aspects, the derivation from legacy to scheduled mode EDCA can be based on a default relation defined in 802.11 standards. In some aspects, the AP 104 may send out an updated relation, such as in a beacon message.

[0067] In some embodiments, the AP 104 may broadcast the EDCA parameter set IE 400 with encryption to carry EDCA parameters (e.g., scheduled mode EDCA parameters) for the first subset of STAs (e.g., scheduled mode STAs). The broadcasted EDCA parameter set IE 400 information is encrypted and can be carried in non-802.11ax PPDUs. In some aspects, the AP 104 may only provide the encryption key to the first subset of STAs (e.g., scheduled mode STAs) which can then decrypt the EDCA parameter set IE 400, while the second subset of STAs (e.g., legacy mode STAs) cannot.

[0068] In some embodiments, the AP 104 may send the EDCA parameter set IE 400 in dedicated resources to carry scheduled mode EDCA parameters. For example, the AP 104 may send the EDCA parameter set IE 400 in dedicated resources (e.g., time/frequency/spatial streams), which can only be received by the first subset of STAs (e.g., scheduled mode STAs). In one aspect, the AP 104 may reserve a frequency channel outside of a non-802.11ax STA operating frequency range, and sends the EDCA parameter set IE 400 carrying scheduled mode EDCA parameters. The first subset of STAs (e.g., scheduled mode STAs) may then tune to the reserved channel to receive the scheduled mode EDCA parameters.

[0069] In other embodiments, default EDCA parameters can be standardized for the first subset of STAs (e.g., scheduled mode STAs). In some aspects, the scheduled mode STAs will use these default EDCA parameters if they do not receive any EDCA parameters intended for them based on any rule. In some aspects, the default scheduled mode EDCA parameters could be defined as those for the background access class (AC) for legacy mode EDCA parameters.

[0070] In some embodiments, the EDCA parameter set IE 400 may carry an indicator forbidding CSMA based SU UL transmissions. In some aspects, the indicator can be a reserved EDCA parameter value (e.g., CWmin=1023 means forbidding CSMA based SU UL Tx for corresponding access category (AC)). In some aspects, the indicator can use new bit(s) in additional to signaled EDCA parameters. In other aspects, the indicator may also specify additional conditions for it to be applied (e.g., forbiddance is only applied to certain traffic identifiers (TIDs), access categories (ACs), info types (e.g. buffer status report), frame types (e.g. control frames), operation modes (e.g. SU UL MIMO Tx), STA states (e.g. unassociated or associated)).

[0071] In some aspects, the AP 104 may decide to use the EDCA parameter set IE 400 for both legacy and scheduled mode STAs, even if a new IE can be defined and used to signal scheduled mode EDCA as described above with respect to FIG. 3. For example, in order to save signaling overhead, the AP 104 may decide to use same EDCA parameters for both groups of STAs (e.g., both scheduled and legacy mode STA types) when the system 100 is lightly loaded. In this case, an indicator can be added in the EDCA parameter set IE 400 to tell scheduled mode STAs if they should ignore the EDCA parameter set IE 400 or not. For example, the indicator may comprise a reserve bit in the EDCA parameter set IE 400 (not shown). Alternatively, a predefined rule can be used in the 802.11 to tell scheduled mode STAs to use the EDCA parameter set IE 400 if only the EDCA parameter set IE 400 presents in certain frame types (e.g., beacons, probe/association response). If decoding a unique IE with EDCA parameters for the first group (e.g., IE 300) in those frame types., the first subset of STAs (e.g., scheduled mode STAs) should update their EDCA parameters based on EDCA parameters for the first group.

[0072] Embodiments described herein also relate to selecting whether a STA 106 should operate in either scheduled or legacy mode. Generally, the first subset of STAs (e.g., scheduled mode STAs) should use scheduled mode EDCA parameters if they are capable of being scheduled by the AP 104 for UL transmission (e.g., UL-MU capable). In some aspects, an EDCA selection decision maker (DM) could be the STA 106 or AP 104, which will decide if the STA 106 should use scheduled or legacy mode EDCA parameters. The DM may decide to use scheduled mode EDCA parameters for the STA 106 based on a number of criterion options. For example, the DM may make its determination based on the capabilities of the STA 106. In these aspects, the DM

decides to use scheduled mode EDCA parameters if both the AP 104 and STA 106 have the capability to perform certain types of scheduled UL transmission, e.g. UL MU-MIMO, UL OFDMA. In some aspects, the STA 106 can know the AP 104 capability based on info in the AP 104's broadcast or probe/association responses. In some aspects, the AP 104 can know the STA 106's capability based on info in the STA 106's probe/association requests.

[0073] In other embodiments, the DM may make its determination based on whether legacy mode transmission results satisfy a performance characteristic. For example, the DM decides to use scheduled mode EDCA parameters if the STA 106's legacy mode transmissions have had poor performance. In one example, if the STA 106 is sending less than X frames in Y sec, the STA 106 using legacy mode EDCA may switch to scheduled mode EDCA and terminate backoff for legacy mode transmissions.

[0074] In some embodiments, the DM may make its determination based whether on scheduled mode transmission results satisfy a performance characteristic. In some aspects, the DM decides to use scheduled mode EDCA parameters only after successful scheduled UL transmissions (e.g., DL ACK is sent or received for the corresponding scheduled UL transmission). This process may verify that both sides indeed have the scheduled mode capability. In some aspects, the STA 106 may use legacy mode EDCA parameters prior to a successful scheduled mode transmission.

[0075] If the STA 106 is the DM, it may inform the AP 104 of its EDCA selection decision in a number of ways. In some aspects, the STA 106 may use implicit signaling. For example, a rule may be defined in the standard such that both the AP 104 and the STA 106 will run the same EDCA selection criterion. In this implementation, the AP 104 will know the STA 106's decision without being informed by the STA 106. In some aspects, the 802.11 standard defines a rule that the STA 106 should use scheduled mode EDCA parameters if both the AP 104 and the STA 106 support scheduled mode UL transmissions. Therefore, the AP 104 may implicitly know STA 106's decision by checking the STA 106's capability without additional signaling. In some aspects, the EDCA selection criterion may be standardized or broadcasted by the AP 104 if there are multiple options, so both the AP 104 and the STA 106 will use same criterion.

[0076] In some embodiments, the STA 106 may use explicit signaling to inform the AP 104 of its EDCA selection decision. For example, the STA 106 may send an indicator to explicitly inform the AP 104 the STA 106's EDCA selection decision. In one aspect, the

indicator may comprise a 1-bit indicator in an existing Receiver Operation Mode Indicator (ROMI) HE control field, in a defined EDCA Operation HE control field, in an uplink multi-user disable field in an Operation Mode Indicator (OMI) A-control field included in a frame sent to the access point, or in certain management frames, e.g., a probe/association request. In some aspects, the indicator can be the STA 106's buffer status report, implying it wants to use scheduled mode EDCA parameters. In other aspects, the indicator may also specify additional conditions to use the selected EDCA parameters (e.g., only use for certain TIDs, info types (e.g. buffer status report), frame types (e.g. control frames), operation modes (e.g. SU UL MIMO Tx), STA states (e.g. unassociated or associated)). In some aspects, after receiving the indicator, the AP 104 may approve/reject/revise the EDCA selection decision and/or additional conditions.

[0077] If the AP 104 is the DM, it may inform the STA 106 of its EDCA selection decision in a number of ways. In some aspects, the AP 104 may use implicit signaling to inform the STA 106. For example, the AP 104 may only send the STA 106 the EDCA IE designated for the first subset of STAs (e.g., scheduled mode STAs) or the second subset of STAs (e.g., legacy mode STAs) in certain frame types (e.g., not send both). In some aspects, the AP 104 may only send the EDCA IE for scheduled mode STAs in probe/association responses or action frames to implicitly inform the STA 106 to use scheduled mode EDCA parameters.

[0078] In some embodiments, the AP 104 may use explicit signaling to inform the STA 106 of its EDCA selection decision. For example, the AP 104 sends an indicator to explicitly inform the STA 106 of the AP 104 EDCA selection decision. In some aspects, the indicator comprises a 1-bit indicator in a potential EDCA configuration HE control field. In other aspects, the indicator may also specify additional conditions to use the selected EDCA parameters, (e.g., only use for certain TIDs, info types (e.g. buffer status report), frame types (e.g. control frames), operation modes (e.g. SU UL MIMO Tx), STA states (e.g. unassociated or associated)). After receiving the indicator, the STA 106 may approve/reject/revise the EDCA selection decision and/or additional conditions.

[0079] Additionally, embodiments described herein also relate to options allowing the first subset of STAs (e.g., scheduled mode STAs) to transition from operating in scheduled mode to operating in legacy mode. In some aspects, a scheduled mode STA 106 may revert back to legacy mode EDCA parameters if selecting scheduled mode EDCA parameters gives poor performance. In these aspects, the fallback to legacy mode

may then provide better performance for the scheduled mode STA 106 and increase throughput. In some aspects, poor performance can be determined by determining that the STA 106 (with buffered data) is not scheduled for UL transmission after "X" seconds. For example, if the AP 104 does not receive an immediate response from the STA 106 to the indicator informing the STA 106 of the AP 104 EDCA selection decision, then the AP 104 may change the previously selected EDCA parameter, or select a second EDCA parameter. In either case, the AP 104 may send an indicator to explicitly inform the STA 106 of the AP 104 subsequent EDCA selection decision. In some aspects the immediate response may refer to a window of time lasting "X" seconds. In another example, a second EDCA parameter may be selected based on a time elapsed since receiving the immediate response from the STA 106 in response to the indication transmitted to the STA 106 from the AP 104. In some aspects, poor performance can be determined by determining that the STA's 106 non-scheduled transmission fails for "Y" attempts. For example, the AP 104 may change the previously selected EDCA parameter, or select a second EDCA parameter, based on a previous transmission that fails from the second wireless device to the first wireless device. In some aspects, poor performance can be determined by determining that the STA 106 is not scheduled after sending the indicator, or UL scheduling request, e.g., buffer status report, for "Z" times, where "Z" may refer to a number of times the indicator is sent. For example, if the AP 104 transmits the indicator to the STA 106 "Z" times, and the STA 106 does not provide a response, then the AP 104 may select a new EDCA or change the current EDCA.

[0080] In some aspects, the values of X, Y, and Z described above may be determined in a number of ways. In some aspects, the values of X, Y, and Z may be defined in standards (e.g., 802.11 standards). In some aspects, the values of X, Y, and Z are determined by the AP 104 and sent by the AP 104 to the STA 106. The AP 104 may determine X/Y/Z based on estimated scheduling latency for intended STAs 106, e.g. X may increase for higher load. In some aspects, the AP 104 may broadcast/multicast/unicast X/Y/Z to intended STAs 106. In some aspects, the values of X, Y, and Z are determined by the STA 106. In some embodiments, the STA 106 may determine and update X/Y/Z based on latency requirement of its traffics. In some aspects, the STA 106 may piggyback X/Y/Z onto its frames, e.g., buffer status report. In some aspects, the values of X, Y, and Z are determined based on negotiation between

the AP 104 and the STA 106. For example, one side can send suggested X/Y/Z to the other, which can further accept/reject/revise it.

[0081] In some embodiments, the first subset of STAs (e.g., scheduled mode STAs) can have a timer/counter to count X/Y/Z. In some aspects, the STA 106 may reset timer/counter to zero based on one or more conditions. For example, the STA 106 may reset timer/counter to zero after the STA 106 knows to use scheduled mode EDCA (e.g., decision made by the AP 104 or the STA 106). In other aspects, the STA 106 may reset timer/counter to zero after the STA 106 wakes up. In other aspects, the STA 106 may reset timer/counter to zero after the STA 106 receives trigger frame scheduling for its UL transmission. In other aspects, the STA 106 may reset timer/counter to zero after the STA 106 trigger frame scheduling for any UL transmission. The trigger frame could be a trigger frame that triggers UL OFDMA random access. In other aspects, the STA 106 may reset timer/counter to zero after the STA 106 transmits a scheduled UL transmission, or transmits a scheduled UL transmission and gets an ACK message. In other aspects, the STA 106 may reset timer/counter to zero after the STA 106 transmits a non-scheduled UL transmission, or transmits a non-scheduled UL transmission and gets an ACK message. In addition, the AP 104 may send a "fallback forbiddance" indicator to forbid fallback to legacy mode EDCA. The AP 104 may broadcast/multicast/unicast this indicator to intended STAs 106. The STAs 106 receiving the indicator may not revert back to legacy mode EDCA parameters after receiving this indicator.

[0082] In some embodiments, fallback to legacy mode EDCA may be restricted to certain traffics. For example, the STA 106 may use legacy mode EDCA for some traffics and other traffics may still use scheduled mode EDCA. In some aspects, traffic restriction may be only applied to certain traffic/info types, or TIDs. For example, only voice and buffer status report can be sent in legacy mode EDCA. In some aspects, traffic restriction may be only applied to certain frame types. For example, only control frames can be sent in legacy mode EDCA. In some aspects, traffic restriction may be only applied to TIDs not scheduled for X seconds. In this case, the fallback decision is per TID, and the STA 106 needs a timer per TID to decide if fallback should occur for each TID.

[0083] FIG. 5 shows a flow chart of an implementation of a method 500 of wireless communication in a wireless communication system. The method 500 may be used to

generate and/or transmit any of the EDCA parameters, the information element 300, or EDCA parameter set IE 400 described in connection with FIGs. 3-4. In some aspects, the EDCA parameters, the information element 300, or EDCA parameter set IE 400 may be transmitted by the AP 104. In addition, the wireless device 202 shown in FIG. 2 may represent a more detailed view of the AP 104 or STA 106, as described above. Thus, in one implementation, one or more of the steps in method 500 may be performed by, or in connection with, a processor and/or transmitter, such as the processor 204, transmitter 210, and HEW component 250 of FIG. 2, although those having ordinary skill in the art will appreciate that other components may be used to implement one or more of the steps described herein. Although the method steps may be described as occurring in a certain order, the steps can be reordered, omitted, and/or additional steps may be added.

[0084] At block 502, the method 500 may include selecting, at an access point, an enhanced distributed channel access (EDCA) parameter for a first subset of stations of a plurality of stations, the first subset of stations capable of transmitting multi-user uplink transmissions. Such selecting may be performed by the processor 204 or the HEW component 250 of the wireless device 202 shown in FIG. 2. At block 504, the method 500 may include generating an information element including the EDCA parameter. For example, the AP 104 may generate the information element 300 or the EDCA parameter set IE 400. Such generating may be performed by the processor 204 or the HEW component 250 of the wireless device 202 shown in FIG. 2. At block 506, the method 500 may include transmitting the information element such that the information element is decodable by the first subset of stations and not by a second subset of stations of the plurality of stations. Such transmitting may be performed by the transmitter 210 of the wireless device 202 shown in FIG. 2.

[0085] The various operations of methods described above may be performed by any suitable means capable of performing the operations, such as various hardware and/or software component(s), circuits, and/or module(s). Generally, any operations illustrated in the Figures may be performed by corresponding functional means capable of performing the operations.

[0086] The various illustrative logical blocks, modules and circuits described in connection with the present disclosure may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated

circuit (ASIC), a field programmable gate array signal (FPGA) or other programmable logic device (PLD), discrete gate or transistor logic, discrete hardware components or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any commercially available processor, controller, microcontroller or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0087] In one or more aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Thus, in some aspects computer readable medium may comprise non-transitory computer readable medium (e.g., tangible media). In addition, in some aspects computer readable medium may comprise transitory computer readable medium (e.g., a signal). Combinations of the above should also be included within the scope of computer-readable media.

[0088] The methods disclosed herein comprise one or more steps or actions for achieving the described method. The method steps and/or actions may be interchanged with one another without departing from the scope of the claims. In other words, unless a specific order of steps or actions is specified, the order and/or use of specific steps and/or actions may be modified without departing from the scope of the claims.

[0089] The functions described may be implemented in hardware, software, firmware or any combination thereof. If implemented in software, the functions may be stored as one or more instructions on a computer-readable medium. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Disk and disc, as used herein, include compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray® disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers.

[0090] Thus, certain aspects may comprise a computer program product for performing the operations presented herein. For example, such a computer program product may comprise a computer readable medium having instructions stored (and/or encoded) thereon, the instructions being executable by one or more processors to perform the operations described herein. For certain aspects, the computer program product may include packaging material.

[0091] Software or instructions may also be transmitted over a transmission medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of transmission medium.

[0092] Further, it should be appreciated that modules and/or other appropriate means for performing the methods and techniques described herein can be downloaded and/or otherwise obtained by a user terminal and/or base station as applicable. For example, such a device can be coupled to a server to facilitate the transfer of means for performing the methods described herein. Alternatively, various methods described

herein can be provided via storage means (e.g., RAM, ROM, a physical storage medium such as a compact disc (CD) or floppy disk, etc.), such that a user terminal and/or base station can obtain the various methods upon coupling or providing the storage means to the device. Moreover, any other suitable technique for providing the methods and techniques described herein to a device can be utilized.

[0093] It is to be understood that the claims are not limited to the precise configuration and components illustrated above. Various modifications, changes and variations may be made in the arrangement, operation and details of the methods and apparatus described above without departing from the scope of the claims.

[0094] While the foregoing is directed to aspects of the present disclosure, other and further aspects of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

WE CLAIM:

1. A method for selecting channel access parameters for communication in a network, the method comprising selecting, at a first wireless device, an enhanced distributed channel access (EDCA) parameter for communication with a second wireless device, wherein selecting the EDCA parameter is based on:

a capability of the first wireless device to receive scheduled uplink transmissions, and

a capability of the second wireless device to transmit multi-user uplink transmissions.

2. The method of claim 1, wherein the first wireless device is one of an access point and a station, and wherein the second wireless device is the other one of the access point and the station.

3. The method of claim 1, further comprising:

transmitting an indication of the selected EDCA parameter to the second wireless device,

determining whether the selected EDCA parameter satisfies a performance characteristic, and

when the selected EDCA fails to satisfy the performance characteristic, selecting a second EDCA parameter.

4. The method of claim 3, wherein selecting the second EDCA parameter is based on a previous transmission from the second wireless device to the first wireless device.

5. The method of claim 3, wherein selecting the second EDCA parameter is based on receiving an immediate response to the indication transmitted to the second wireless device.

6. The method of claim 3, wherein selecting the second EDCA parameter is based on failure to receive a response from the second wireless device after

transmitting an indication of the selection of the EDCA parameter to the second wireless device a number of times.

7. The method of claim 1, further comprising generating an information element, the information element comprising a variable length of bits, wherein the variable length of bits is based on at least one of a type of signal and a service provider.

8. The method of claim 1, wherein selecting the EDCA parameter further comprises selecting the EDCA parameter based on a type of the second wireless device.

9. The method of claim 1, further comprising classifying the second wireless device into a subset of wireless devices, the subset of wireless devices being one of a plurality of subsets of wireless devices, wherein the classification is based on a type of the second wireless device and a multi-user uplink capability of the second wireless device.

10. The method of claim 9, further comprising selecting, at the first wireless device, the EDCA parameter for communication with the second wireless device based on the subset of wireless devices.

11. The method of claim 1, wherein the EDCA parameter comprises at least one of a minimum contention window (CWmin), a maximum contention window (CWmax), a transmit opportunity (TXOP), a transmission opportunity limit (TXOP limit), and an arbitration inter frame space (AIFS).

12. The method of claim 1, wherein the first wireless device appends one or more rules for the first wireless device to the EDCA parameter.

13. The method of claim 1, wherein the second wireless device is triggered by the first wireless device via the multi-user uplink transmissions to send a single-user uplink transmission.

14. The method of claim 13, wherein the second wireless device operates in at least one of a non-high throughput mode and a very high throughput mode.

15. The method of claim 1, further comprising advertising, by the first wireless device, the EDCA parameter via an information element, wherein the information element includes at least one of an element identification field, a length field, another information field, and an extension field.

16. An apparatus for wireless communication, comprising:

a processing system configured to select, at a first wireless device, an enhanced distributed channel access (EDCA) parameter for communication with a second wireless device, wherein selecting the EDCA parameter is based on:

a capability of the first wireless device to receive scheduled uplink transmissions uplink transmissions, and

a capability of the second wireless device to transmit multi-user uplink transmissions.

17. The apparatus of Claim 16, further comprising a transmitter configured to transmit an indication of the selection of the EDCA parameter to the second wireless device.

18. The apparatus of claim 16, wherein the processing system is further configured to select the EDCA parameter based on a capability of the first wireless device to receive scheduled uplink transmissions uplink transmissions and a capability of the second wireless device to transmit multi-user uplink transmissions.

19. The apparatus of claim 16, wherein selecting the EDCA parameter further comprises selecting the EDCA parameter based on a type of the second wireless device.

20. The apparatus of claim 16, wherein the processing system is further configured to classify the second wireless device into a subset of wireless devices,

the subset of wireless devices being one of a plurality of subsets of wireless devices, wherein the classification is based on a type of the second wireless device and a multi-user uplink capability of the second wireless device.

21. The apparatus of claim 20, wherein the EDCA parameter is selected based on the subset of wireless devices.

22. The apparatus of claim 16, wherein the EDCA parameter comprises at least one of a minimum contention window (CWmin), a maximum contention window (CWmax), a transmit opportunity (TXOP), a transmission opportunity limit (TXOP limit), and an arbitration inter frame space (AIFS).

23. The apparatus of claim 16, wherein the first wireless device appends one or more rules for the first wireless device to the EDCA parameter.

24. The apparatus of claim 16, wherein the second wireless device is triggered by the first wireless device via the multi-user uplink transmissions to send a single-user uplink transmission.

25. The apparatus of claim 24, wherein the second wireless device operates in at least one of a non-high throughput mode and a very high throughput mode.

26. The apparatus of claim 16, wherein the processing system is further configured to advertise, by the first wireless device, the EDCA parameter via an information element, wherein the information element includes at least one of an element identification field, a length field, another information field, and an extension field.

27. A non-transitory computer-readable medium comprising code that, when executed, causes an apparatus to select, at a first wireless device, an enhanced distributed channel access (EDCA) parameter for communication with a second wireless device, wherein selecting the EDCA parameter is based on:

a capability of the first wireless device to receive scheduled uplink

transmissions, and

a capability of the second wireless device to transmit multi-user uplink transmissions.

28. The non-transitory computer-readable medium of claim 27, further comprising code that, when executed, causes the apparatus to advertise, by the first wireless device, the EDCA parameter via an information element, wherein the information element includes at least one of an element identification field, a length field, another information field, and an extension field.

29. The non-transitory computer-readable medium of claim 27, further comprising code that, when executed, causes the apparatus to transmit an indication of the selection of the EDCA parameter to the second wireless device.

30. The non-transitory computer-readable medium of claim 27, further comprising code that, when executed, causes the apparatus to classify the second wireless device into a subset of wireless devices, the subset of wireless devices being one of a plurality of subsets of wireless devices, wherein the classification is based on a type of the second wireless device and a multi-user uplink capability of the second wireless device.

Dated this 5th day of June 2018



Archana Shanker
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ABSTRACT

METHODS AND APPARATUS FOR SELECTING ENHANCED DISTRIBUTED CHANNEL ACCESS PARAMETERS FOR DIFFERENT STATIONS

In some aspects, a method for configuring channel access parameters in a wireless communication system includes determining, at an access point, an enhanced distributed channel access (EDCA) parameter for a first subset of stations of a plurality of stations, the first subset of stations capable of transmitting multi-user uplink transmissions. The method further includes generating an information element including the EDCA parameter. The method further includes transmitting the information element such that the information element is decodable by the first subset of stations and not by a second subset of stations of the plurality of stations.

REFER TO FIGURE 1

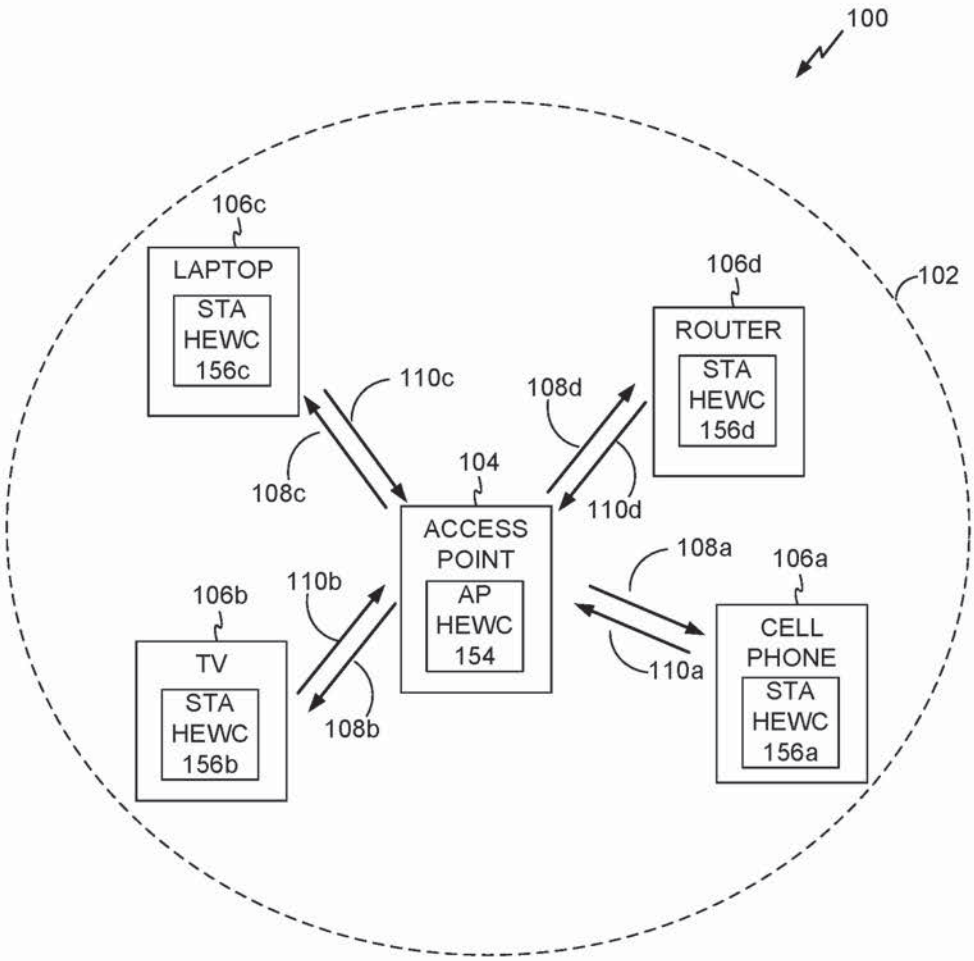


FIG. 1

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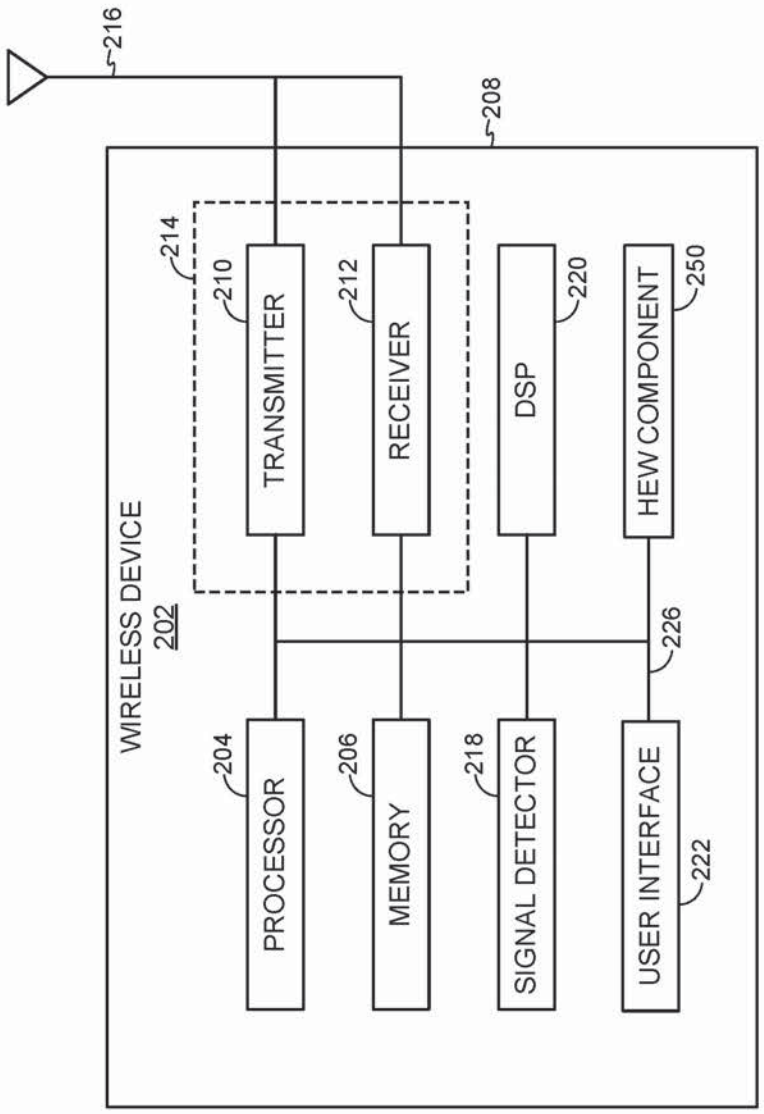


FIG. 2

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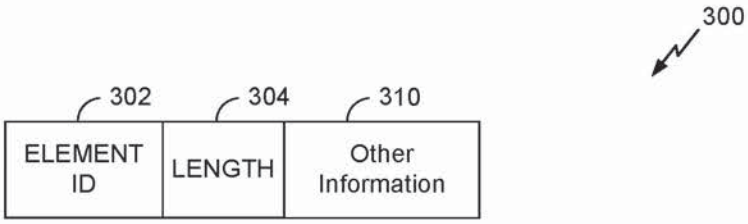


FIG. 3

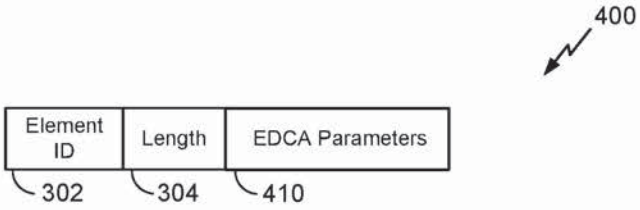


FIG. 4

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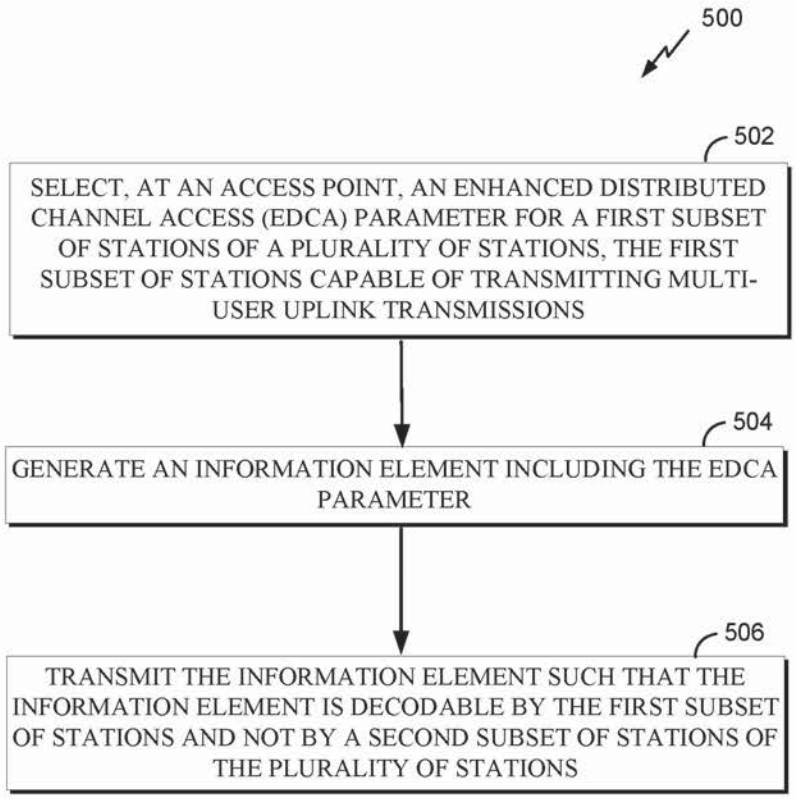


FIG. 5

Archana shanker
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Electronic Acknowledgement Receipt

EFS ID:	40696117
Application Number:	16294883
International Application Number:	
Confirmation Number:	6210
Title of Invention:	WIRELESS COMMUNICATION METHOD USING ENHANCED DISTRIBUTED CHANNEL ACCESS, AND WIRELESS COMMUNICATION TERMINAL USING SAME
First Named Inventor/Applicant Name:	Woojin Ahn
Customer Number:	158747
Filer:	Young Seok Koo/Azatuhi Chinaryan
Filer Authorized By:	Young Seok Koo
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2020-09-28_631950_IDS.pdf	266454 02fb13a0010f95eb8128147f7e85b9f1f3e794a9	yes	5

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	3
	Information Disclosure Statement (IDS) Form (SB08)	4	4
	Transmittal Letter	5	5

Warnings:					
Information:					
2	Other Reference-Patent/App/Search documents	Ref1_JP2019-534619_OA.pdf	188126 68afeda6a8713f201291b51cce75c022f83b6a33	no	7
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	Ref2_US16596674_1stOA.pdf	716147 8243f693bd110ee63e033921aca0d5ddfe69f012	no	19
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	Ref5_US16188274_NOA.pdf	610878 99582aace5941eb2492a81c1e0492636e07e94c2	no	16
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	Ref6_KR10-2020-7026125_NOA.pdf	143713 20a7b675a60fb1d12dbb6c08e0d296400f830f6e	no	4
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	Ref7_KR10-2018-7033463_1stOA.pdf	221330 5a4a284ecfce8bff36b7993011e2763a94548e4c	no	10
Warnings:					
Information:					

7	Non Patent Literature	Ref8_IEEE_802-11-16_0399r1.pdf	249268 498606ab964129902c13c78f1d3a2b5c55499c19	no	11
Warnings:					
Information:					
8	Foreign Reference	Ref9_WO2015-199306.pdf	1758749 48a0e4be0f10261b8ae710a9ff1b3fdb616931f5	no	153
Warnings:					
Information:					
9	Other Reference-Patent/App/Search documents	Ref10_IN201927007972_1stOA.pdf	242709 255c1274ef3178536de37ba1cf115df822ff0250	no	6
Warnings:					
Information:					
10	Foreign Reference	Ref11_WO2016-123403.pdf	1094920 583c8cc452bca9ae22b5f7fba823860accae5eab	no	119
Warnings:					
Information:					
11	Foreign Reference	Ref12_IN201847021036_Complete_specification.pdf	685941 9b25242dfbd3c5d4ae37123344fea45e74e934a3	no	39
Warnings:					
Information:					
		Total Files Size (in bytes):	6178235		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC. & SK TELECOM CO., LTD.	Examiner: Randhawa, Mandish K
Serial No.: 16/294,883	Art Unit: 2477
Filing or 371 (c) Date: March 6, 2019	Conf. No.: 6210
For: "WIRELESS COMMUNICATION METHOD USING ENHANCED DISTRIBUTED CHANNEL ACCESS, AND WIRELESS COMMUNICATION TERMINAL USING SAME"	Our Ref: B-9905CON 631950-4
Date: September 28, 2020	Re: ***Information Disclosure Statement***

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir/Madam:

This information disclosure statement is filed in accordance with 37 C.F.R. §§ 1.56, 1.97 and 1.98 to disclose information that may be relevant to the above-identified patent application. The Applicant requests the Examiner consider the documents listed on the enclosed form PTO-1449 (modified) in the examination of this application.

The filing of this Information Disclosure Statement (IDS) shall not be construed as a representation that a search has been made (37 C.F.R. 1.97(g)), an admission that the information cited is, or is considered to be, material to patentability, or that no other material information exists.

The filing of this Information Disclosure Statement shall not be construed as an admission against interest in any manner (37 C.F.R § 1.97(h)).

If any additional fee is required for this filing, the Applicant requests the Examiner contact a practitioner associated with the Customer Number listed below for authorization.

This information disclosure statement also includes the statements marked below. Failure to mark a statement should not be construed as a negative assertion.

Timing and Fees

This IDS is being filed:

[ ] Concurrently with the application, and no fee is due.

[ ] Within three months of the filing of the national application, other than a continued prosecution application under § 1.53(d), and no fee is due.

[ ] Within three months of the date of entry of the national stage as set forth in § 1.491 in an international application, and no fee is due.

[ ] Before the mailing of a first Office Action on the merits, and no fee is due.

[ ] Before the mailing of a first Office Action after the filing of a request for continued examination under§ 1.114, and no fee is due.

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[x] After the periods described above, and before a final Office Action under § 1.113, a Notice of Allowance under § 1.311, or an action that otherwise closes prosecution in the application, and is

- [ ] accompanied by the fee set forth in § 1.17(p), or
- [x] filed with the statement set forth in 37 C.F.R. 1.97(e)(1): That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement; or
- [ ] filed with the statement set forth in 37 C.F.R. 1.97(e)(2): That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement.

[ ] After the periods described above, and is accompanied by the fee set forth in § 1.17(p), and is

- [ ] filed with the statement set forth in 37 C.F.R. 1.97(e)(1), that each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement; or

- [ ] filed with the statement set forth in 37 C.F.R. 1.97(e)(2), that no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement.

[ ] Concurrently with a Request for Continued Examination, and no additional fee is due for this IDS.

Items Disclosed

At least one item listed on the enclosed form PTO-1449 (modified) was

[x] Cited in an Office Action for a related application, the application number of the related application and the issue date of the Office Action are provided below and the Office Action is enclosed.

Please see the enclosed form PTO-1449 (modified) for related application number(s) and issue date(s).

[ ] Cited in an International Search Report (ISR) or an International Preliminary Report on Patentability (IPRP) or a Written Opinion (WO) of the International Searching Authority (ISA) for the related PCT Application, the PCT application number and the issue date of the ISR/IPRP/WO are provided below and the ISR/IPRP/WO is enclosed.

Additional Information

[x] Translations of the foreign-language documents are also enclosed as machine-translations, human-translations, or counterpart applications as noted. Machine translations were provided by the Japanese Patent Office, ESPACENET, Google Documents, Patent Fetcher® /ESPACENET, Google Translate or Google Translator Toolkit as noted and with OCR by Adobe Acrobat 9 or ABBYY PDF Transformer 3 if needed.

[x] English-language abstracts of foreign-language documents are provided.

[x] Documents listed on the enclosed ISR/IPRP/WO or the Office Action have relevance at least as described therein.

[ ] The documents with the following reference numbers were described in the specification of the present application; omission of a reference from this list does not indicate that it was not discussed in the specification of the present application.

[x] At least one of the references cited in the Office Action listed on the attached PTO-1449 (modified) were previously submitted in an IDS or cited by the Examiner for the present application on March 6, 2019 and March 4, 2020 and therefore are not submitted in this IDS.

[x] Other: copy of the statement as set forth under 37 C.F.R. 1.97(e)(1).

I hereby certify that this document is being transmitted to the Patent and Trademark Office via electronic filing.

September 28, 2020
(Date of Transmission)

Azatuhi Chinaryan
(Name of Person Transmitting)

/ Azatuhi Chinaryan /
(Signature)

Respectfully submitted,

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/294,883	Filing Date 03/06/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	09/22/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 11	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/SHANDA E ROSS/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Woojin AHN	Examiner:	Randhawa, Mandish K
Application No.:	16/294,883	Confirmation No.:	6210
Filing Date:	March 6, 2019	Group Art Unit:	2477
Title:	WIRELESS COMMUNICATION METHOD USING ENHANCED DISTRIBUTED CHANNEL ACCESS, AND WIRELESS COMMUNICATION TERMINAL USING SAME	Attorney Docket:	B-9905CON 631950-4
		Date:	September 22, 2020
		Re:	**Response to Non-Final Office Action of June 23, 2020**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

RESPONSE TO OFFICE ACTION

Sir:

This paper is timely submitted in response to the non-Final Office Action mailed on June 23, 2020 for the subject application. Please amend the application as follows and consider the Remarks/Arguments set forth below.

Amendments to the Claims begin on page 2 of this paper.

Remarks/Arguments begin on page 6 of this paper.

All Amendments and Remarks/Arguments are made without prejudice or disclaimer.

AMENDMENTS TO THE CLAIMS

Please amend the claims to read as indicated in the following list of claims:

Listing of claims

1-20. (Canceled).

21. (Currently Amended) A wireless communication terminal that wirelessly communicates with a base wireless communication terminal, the wireless communication terminal comprising:

a transceiver; and

a processor,

wherein the processor is configured to:

transmit, to the base wireless communication terminal, a trigger-based physical layer protocol data unit (PPDU) using the transceiver,

switch a parameter set, which is a set of parameters used for the channel access, from a first parameter set to a second parameter set based on whether the base wireless communication terminal triggers a multi-user uplink transmission participation of the wireless communication terminal,

when a MAC protocol data unit (MPDU) included in the trigger-based PPDU does not request an immediate response, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends,

when the MPDU included in the trigger-based PPDU requests the immediate response, set the second parameter set timer for the access category of the MPDU for which immediate response is received,

~~set a second parameter set timer based on whether a response to a MAC protocol data unit (MPDU) included in the trigger-based PPDU is received,~~

when the second parameter set timer expires, terminate an application of the second parameter set, and

access a channel according to a priority of data to be transmitted to the base communication terminal by the wireless communication terminal and the parameter set.

22-25. (Canceled).

26. (Previously Presented) The wireless communication terminal of claim 21, wherein the MPDU included in the trigger-based PPDU is a QoS data frame.

27. (Previously Presented) The wireless communication terminal of claim 21, wherein the processor is configured to receive a beacon frame from the base wireless communication terminal and obtain information indicating a period of the second parameter set timer from the beacon frame.

28. (Previously Presented) The wireless communication terminal of claim 21, wherein when switching the parameter set from the first parameter set to the second parameter set, the processor is configured to set the second parameter set timer.

29. (Previously Presented) The wireless communication terminal of claim 21, wherein the processor is configured to calculate a random integer value within a contention window (CW),

set a backoff timer based on the random integer value, and

access the channel based on the back off timer and a predetermined slot time,

wherein the parameter set comprises a minimum value (CWmin) of the CW and a maximum value (CWmax) of the CW.

30. (Previously Presented) The wireless communication terminal of claim 21, wherein the processor is configured to calculate a random integer value in a contention window (CW),

set a backoff timer based on the random integer value,

access the channel based on the back off timer and a predetermined slot time, and

if a value of the CW is greater than the maximum value (CWmax) of the CW according to a priority of the data to be transmitted, sets the value of the CW to the CWmax.

31. (Previously Presented) The wireless communication terminal of claim 21, wherein the processor is configured to operate a plurality of queues that are classified according to an access

category of data stored in a queue and performs backoff procedure of accessing a channel based on a time corresponding to a backoff timer in each of the plurality of queues, and

when there is no data stored in the queue and the backoff timer corresponding to the queue is 0, perform no operation at a slot boundary of the backoff timer,

wherein the backoff timer is set based on a random integer value calculated in a contention window (CW), and is reduced when the channel is idle for a predetermined slot time.

32. (Previously Presented) The wireless communication terminal of claim 31, wherein when there is no data stored in the queue and the backoff timer corresponding to the queue is 0, the processor is configured to maintain the backoff timer to be 0.

33. (Currently Amended) An operation method of a wireless communication terminal that wirelessly communicates with a base wireless communication terminal, the method comprising:

transmitting a trigger-based physical layer protocol data unit (PPDU) to the base wireless communication terminal using the transceiver;

switching a parameter set, which is a set of parameters used for the channel access, from a first parameter set to a second parameter set based on whether the base wireless communication terminal triggers a multi-user uplink transmission participation of the wireless communication terminal;

when a MAC protocol data unit (MPDU) included in the trigger-based PPDU does not request an immediate response, setting a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends;

when the MPDU included in the trigger-based PPDU requests the immediate response, setting the second parameter set timer for the access category of the MPDU for which immediate response is received;

~~setting a second parameter set timer based on whether the response to the MPDU included in the trigger-based PPDU is received;~~

when the second parameter set timer expires, terminating an application of the second parameter set;

accessing a channel according to a priority of data to be transmitted to the base wireless communication terminal and the parameter set; and

transmitting the data through the channel.

34-37. (Canceled).

38. (Previously Presented) The method of claim 33, wherein the MPDU included in the trigger-based PPDU is a QoS data frame.

39. (Previously Presented) The method of claim 33, the method further comprising:

receiving a beacon frame from the base wireless communication terminal; and

obtaining information indicating a period of the second parameter set timer from the beacon frame.

40. (Previously Presented) The method of claim 33, wherein the switching the parameter set from the first parameter set to the second parameter set comprises

setting the second parameter set timer when the switching the parameter set from the first parameter set to the second parameter set.

REMARKS/ARGUMENTS

The following Remarks/Arguments are in response to the non-Final Office Action mailed on June 23, 2020 (hereinafter "Office Action") for the subject application. Pending in the application are claims 21-40.

In the Office Action, claims 21-23, 26-28, 33-35 and 38-40 stand rejected under 35 U.S.C. §103 as allegedly being obvious over U.S. Patent Application Publication No. 2017/0325264 (hereinafter "Cherian") in view of IEEE 802.11-16/1180r (hereinafter "IEEE"). Claims 21, 22, 24, 25, 33, 34, 36 and 37 stand rejected under 35 U.S.C. §103 as allegedly being obvious over Cherian in view of U.S. Patent Application Publication No. 2017/0202023 (hereinafter "Zhou"). Claims 29 and 30 stand rejected under 35 U.S.C. §103 as allegedly being obvious over Cherian in view of IEEE and U.S. Patent Application Publication No. 2016/0066257 (hereinafter "Liu"). Claims 31 and 32 stand rejected under 35 U.S.C. §103 as allegedly being obvious over Cherian in view of IEEE and U.S. Patent Application Publication No. 2019/0313453 (hereinafter "Baron").

In this response, claims 21 and 33 are amended. No new matter is presented as a result of these amendments. Claims 22-25 and 34-37 are canceled. No new claim is added. Claims 1-20 were previously canceled. Accordingly, the claims pending in this application after entry of this response are claims 21, 26-33 and 38-40.

For at least the following reasons, this application should be considered in condition for allowance and passed to issuance.

Claim Rejections – 35 U.S.C. §103

In the Office Action, claims 21-23, 26-28, 33-35 and 38-40 stand rejected under 35 U.S.C. §103 as allegedly being obvious over Cherian in view of IEEE (See Office Action: item 6 at page 3). Claims 21, 22, 24, 25, 33, 34, 36 and 37 stand rejected under 35 U.S.C. §103 as allegedly being obvious over Cherian in view of Zhou (See Office Action: item 7 at page 8). Claims 29 and 30 stand rejected under 35 U.S.C. §103 as allegedly being obvious over Cherian in view of IEEE and Liu (See Office Action: item 8 at page 11). Claims 31 and 32 stand rejected under 35 U.S.C. §103 as allegedly being obvious over Cherian in view of IEEE and Baron (See

Office Action: item 9 at page 13). These rejections are hereby traversed, and reconsideration and withdrawal are respectfully requested.

Claim 21

Claim 21 recites:

> *A wireless communication terminal that wirelessly communicates with a base wireless communication terminal, the wireless communication terminal comprising:*
> *a transceiver; and*
> *a processor,*
> *wherein the processor is configured to:*
> *transmit, to the base wireless communication terminal, a trigger-based physical layer protocol data unit (PPDU) using the transceiver,*
> *switch a parameter set, which is a set of parameters used for the channel access, from a first parameter set to a second parameter set based on whether the base wireless communication terminal triggers a multi-user uplink transmission participation of the wireless communication terminal,*
> *when a MAC protocol data unit (MPDU) included in the trigger-based PPDU does not request an immediate response, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends,*
> *when the MPDU included in the trigger-based PPDU requests the immediate response, set the second parameter set timer for the access category of the MPDU for which immediate response is received,*
> *when the second parameter set timer expires, terminate an application of the second parameter set, and*
> *access a channel according to a priority of data to be transmitted to the base communication terminal by the wireless communication terminal and the parameter set.*

Although the Applicant respectfully disagrees with the Examiner, solely to expedite prosecution of the present application and allowance of the claims, claim 21 is amended to add "*when a MAC protocol data unit (MPDU) included in the trigger-based PPDU does not request an immediate response, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, when the MPDU included in the trigger-based PPDU requests the immediate response, set the second parameter set timer for the access category of the MPDU for which immediate response is received*".

References Cherian in view of IEEE

The Applicant cannot find any disclosure, teaching or suggestion in Cherian or IEEE that "*the processor is configured to … when a MAC protocol data unit (MPDU) included in the trigger-based PPDU does not request an immediate response, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] when the MPDU included in the trigger-based PPDU requests the immediate response, set the second parameter set timer for the access category of the MPDU for which immediate response is received*" as recited in claim 21 (emphasis added). Therefore, it is respectfully submitted that claim 21 is not obvious over Cherian in view of IEEE, and requests reconsideration and withdrawal of the §103 rejection of claim 21.

References Cherian in view of Zhou

Cherian and Zhou fail to disclose, teach or suggest that "*the processor is configured to … **when** a MAC protocol data unit (MPDU) included in the trigger-based PPDU does **not request** an **immediate response**, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] **when** the MPDU included in the trigger-based PPDU **requests** the **immediate response**, set the second parameter set timer for the access category of the MPDU for which immediate response is received*" as recited in claim 21 (emphasis added).

The Office Action acknowledges that "Cherian does not explicitly teach, wherein the processor is configured to determine when to set the second parameter set timer based on a type of responding requested by the MPDU included in the trigger-based PPDU" (Office Action: page 11). Accordingly, Cherian does not disclose, teach or suggest that "*the processor is configured to … **when** a MAC protocol data unit (MPDU) included in the trigger-based PPDU does **not request** an **immediate response**, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] **when** the MPDU included in the trigger-based PPDU **requests** the **immediate response**, set the second parameter set timer for the access category of the MPDU for which immediate response is received*" as recited in claim 21 (emphasis added).

Further, Zhou fails to make up the deficiency of Cherian with respect to the limitation of claim 21 that "*the processor is configured to … **when** a MAC protocol data unit (MPDU) included in the trigger-based PPDU does **not request** an **immediate response**, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] **when** the MPDU included in the trigger-based PPDU **requests** the **immediate response**, set the second parameter set timer for the access category of the MPDU for which immediate response is received*" as recited in claim 21 (emphasis added). In the Office Action, the Examiner indicates that "Zhou teaches the wireless communication terminal may set second parameter timer after the wireless communication terminal transmits a scheduled UL transmission, or transmits a scheduled UL transmission and gets an ACK message (Provisional application No. 62/278,268: ¶[0081])" (Office Action: page 11). Paragraph [0081] of Provisional Application No. 62/278,268 of Zhou states that "the STA 106 may reset timer/counter to zero after the STA 106 transmits a scheduled UL transmission, or transmits a scheduled UL transmission and gets an ACK message" (emphasis added). However, "reset[ting] timer/counter to zero after the STA 106 transmits a scheduled UL transmission, or transmits a scheduled UL transmission and gets an ACK message" in Zhou is not a disclosure, teaching or suggestion that "*the processor is configured to … **when** a MAC protocol data unit (MPDU) included in the trigger-based PPDU does **not request** an **immediate response**, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] **when** the MPDU included in the trigger-based PPDU **requests** the **immediate response**, set the second parameter set timer for the access category of the MPDU for which immediate response is received*" as recited in claim 21 (emphasis added). Further, the "scheduled UL transmission" referred in paragraph [0081] of Provisional Application No. 62/278,268 of Zhou does not indicate a type of response, but indicates an initiation type of the UL transmission. Additionally, nowhere does Zhou mention the "***immediate response***" recited in claim 21 (emphasis added). Hence, Zhou does not cure Cherian's failure of teaching that "*the processor is configured to … **when** a MAC protocol data unit (MPDU) included in the trigger-based PPDU does **not request** an **immediate response**, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] **when** the MPDU included in the trigger-based PPDU **requests** the **immediate response**, set the*

second parameter set timer for the access category of the MPDU for which immediate response is received" as recited in claim 21 (emphasis added).

For at least the foregoing reasons, the Applicant respectfully submits that claim 21 is not obvious over Cherian in view of Zhou, and requests reconsideration and withdrawal of the §103 rejection of claim 21.

* * *

For completeness of reasoning, neither Liu nor Baron discloses, teaches or suggests that "*the processor is configured to ... **when** a MAC protocol data unit (MPDU) included in the trigger-based PPDU does **not request** an **immediate response**, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] **when** the MPDU included in the trigger-based PPDU **requests** the **immediate response**, set the second parameter set timer for the access category of the MPDU for which immediate response is received*" as recited in claim 21 (emphasis added). Hence, Liu and Baron do not make up the deficiency of the combination of Cherian and IEEE with respect to the limitation of claim 21 that "*the processor is configured to ... **when** a MAC protocol data unit (MPDU) included in the trigger-based PPDU does **not request** an **immediate response**, set a second parameter set timer for an access category of the MPDU when the transmission of the trigger-based PPDU ends, [and] **when** the MPDU included in the trigger-based PPDU **requests** the **immediate response**, set the second parameter set timer for the access category of the MPDU for which immediate response is received*" (emphasis added). Accordingly, the Applicant respectfully submits that claim 21 is not obvious over obvious over Cherian in view of IEEE and Liu or over Cherian in view of IEEE and Baron.

Claim 33

The Applicant respectfully submits that arguments similar to the arguments set forth for claim 21 can be used, *mutatis mutandis*, to show that claim 33 is patentable under 35 U.S.C. §103, and requests reconsideration and withdrawal of the §103 rejection of claim 33.

Claims 26-32 and 38-40

"If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious." *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). As discussed above, claims 21 and 33 are patentable under 35 U.S.C. §103. Claims 26-32 and 38-40 depend from claim 21 or 33. Therefore, the Applicant respectfully submits that claims 26-32 and 38-40 are patentable under 35 U.S.C. §103 at least by way of their dependencies on claims 21 and 33, and requests reconsideration and withdrawal of the §103 rejections of claims 26-32 and 38-40.

Claims 22-25 and 34-37

Although the Applicant respectfully disagrees with the Examiner, solely to expedite prosecution of the present application and allowance of the claims, claims 22-25 and 34-37 are canceled, rendering the rejections moot.

CONCLUSION

It is believed that all of the grounds of rejection have been properly traversed, accommodated, or rendered moot. The Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action and the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (323) 934-2300.

The Commissioner is authorized to charge any additional fees which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, then the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136 (a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

I hereby certify that this document is being transmitted electronically to the United States Patent and Trademark Office via electronic filing.

September 22, 2020
(Date of Transmission)

Young Seok Koo
(Name of Person Transmitting)

/ Young Seok Koo /
(Signature)

Respectfully submitted,

/ Young Seok Koo 76,255 /

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Fax No.: (323) 934-0202

Electronic Acknowledgement Receipt

EFS ID:	40634613
Application Number:	16294883
International Application Number:	
Confirmation Number:	6210
Title of Invention:	WIRELESS COMMUNICATION METHOD USING ENHANCED DISTRIBUTED CHANNEL ACCESS, AND WIRELESS COMMUNICATION TERMINAL USING SAME
First Named Inventor/Applicant Name:	Woojin Ahn
Customer Number:	158747
Filer:	Young Seok Koo
Filer Authorized By:	
Attorney Docket Number:	B-9905CON 631950-4
Receipt Date:	22-SEP-2020
Filing Date:	06-MAR-2019
Time Stamp:	18:33:00
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		ResponseToOA06_23_2020_631950_4US.pdf	92218 6b55ae54c984ecded79a8b4a2ace62fe55d1b99c	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	12
Warnings:			
Information:			
	Total Files Size (in bytes):	92218	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Form PTO-1449 (Modified) Page 1 of 1	ATTY DOCKET NO. B-9905CON 631950-4	U.S. SERIAL NO. 16/294,883
LIST OF PATENTS AND PUBLICATIONS STATEMENT	APPLICANT WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC. & SK TELECOM CO., LTD.	FILING DATE OR 371 (C) DATE March 6, 2019
		GROUP NO. 2477

U.S. PATENT DOCUMENTS

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT NUMBER	ISSUE/PUBL. DATE	NAME	CLASS	SUB-CLASS	REMARKS
	1.	2017/0230981	Aug. 10, 2017	RYU et al.			
	2.	2017/0257887	Sep. 7, 2017	Ghosh et al.			
	3.	2019/0182864	Jun. 13, 2019	HUANG et al.			
	4.	2017/0245261	Aug. 24, 2017	Cariou et al.			
	5.	2016/0198500	Jul. 7, 2016	MERLIN et al.			
	6.	2010/0081393	Apr. 1, 2010	Huang			

FOREIGN PATENT DOCUMENTS

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT NUMBER	PUBLICATION DATE	COUNTRY	CLASS	SUB-CLASS	TRANSLATION

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT
	7.	Office Action dated April 16, 2020 for U.S. Patent Application No. 16/188,274
	8.	Office Action dated May 14, 2020 for U.S. Patent Application No. 16/361,283
	9.	Laurent Cariou et al.: "Proposed spec text for MU EDCA parameters", Resolution for CID 9058 and 90751, IEEE P802.11, Wireless LANs, September 1, 2016. See pp. 1-7
	10.	Notice of Allowance dated June 18, 2020 for Korean Patent Application No. 10-2020-7002361 and its English translation provided by the Applicant's foreign counsel
	11.	Extended European Search Report dated May 12, 2020 for European Patent Application No. 17849113.0
	12.	Notice of Allowance dated June 22, 2020 for Japanese Patent Application No. 2019-500497 and its English translation provided by the Applicant's foreign counsel

EXAMINER	*DATE CONSIDERED*

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. sInclude copy of this form with next communication to applicant.

STATEMENT UNDER 37 C.F.R. 1.97(e)(1)

Each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

Date: 15 July, 2020

Sungjin HONG
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Electronic Acknowledgement Receipt

EFS ID:	40015114
Application Number:	16294883
International Application Number:	
Confirmation Number:	6210
Title of Invention:	WIRELESS COMMUNICATION METHOD USING ENHANCED DISTRIBUTED CHANNEL ACCESS, AND WIRELESS COMMUNICATION TERMINAL USING SAME
First Named Inventor/Applicant Name:	Woojin Ahn
Customer Number:	158747
Filer:	Young Seok Koo/Azatuhi Chinaryan
Filer Authorized By:	Young Seok Koo
Attorney Docket Number:	B-9905CON 631950-4
Receipt Date:	16-JUL-2020
Filing Date:	06-MAR-2019
Time Stamp:	21:07:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Other Reference-Patent/App/Search documents	Ref1_US16188274_1stOA.pdf	280566 b5f140d8e6352d3c61c0c860f568459256ba746a	no	9

Warnings:

Information:					
2	Other Reference-Patent/App/Search documents	Ref5_US16361283_1stOA.pdf	653008 7d91cb355213a5a0c1ff0f0ab72683f41d3e56d1	no	17
Warnings:					
Information:					
3	Non Patent Literature	Ref9_IEEE_P802-11_Proposed_spec_text.pdf	719623 2d38dc5a656cb0bad5084007d94c87c104372bf3	no	7
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	Ref10_KR10-2020-7002361_NOA.pdf	502583 dcbc0dcc78904cac032232f7f43316af259aad42	no	7
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	Ref11_EP178491130_EESR.pdf	470079 022b4ad4e4e53874165a36bf20519067f31a4d88	no	7
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	Ref12_JP2019-500497_NOA.pdf	136703 fb70edce15d2c9a3cc61397133a6252e6cc7464e	no	6
Warnings:					
Information:					
7		2020-07-15_631950_IDS.pdf	188560 8f21883f6f3beabb8c1ad64deacb09db8caaa2af	yes	5

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Transmittal Letter	1	3
Information Disclosure Statement (IDS) Form (SB08)	4	4
Transmittal Letter	5	5

Warnings:	
Information:	
Total Files Size (in bytes):	2951122

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC. & SK TELECOM CO., LTD.	Examiner: RANDHAWA, MANDISH K
Serial No.: 16/294,883	Art Unit: 2477
Filing or 371 (c) Date: March 6, 2019	Conf. No.: 6210
For: "WIRELESS COMMUNICATION METHOD USING ENHANCED DISTRIBUTED CHANNEL ACCESS, AND WIRELESS COMMUNICATION TERMINAL USING SAME"	Our Ref: B-9905CON 631950-4
Date: July 16, 2020	Re: ***Information Disclosure Statement***

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir/Madam:

This information disclosure statement is filed in accordance with 37 C.F.R. §§ 1.56, 1.97 and 1.98 to disclose information that may be relevant to the above-identified patent application. The Applicant requests the Examiner consider the documents listed on the enclosed form PTO-1449 (modified) in the examination of this application.

The filing of this Information Disclosure Statement (IDS) shall not be construed as a representation that a search has been made (37 C.F.R. 1.97(g)), an admission that the information cited is, or is considered to be, material to patentability, or that no other material information exists.

The filing of this Information Disclosure Statement shall not be construed as an admission against interest in any manner (37 C.F.R § 1.97(h)).

If any additional fee is required for this filing, the Applicant requests the Examiner contact a practitioner associated with the Customer Number listed below for authorization.

This information disclosure statement also includes the statements marked below. Failure to mark a statement should not be construed as a negative assertion.

Timing and Fees

This IDS is being filed:

[ ] Concurrently with the application, and no fee is due.

[ ] Within three months of the filing of the national application, other than a continued prosecution application under § 1.53(d), and no fee is due.

[ ] Within three months of the date of entry of the national stage as set forth in § 1.491 in an international application, and no fee is due.

[ ] Before the mailing of a first Office Action on the merits, and no fee is due.

[ ] Before the mailing of a first Office Action after the filing of a request for continued examination under§ 1.114, and no fee is due.

---

[x] After the periods described above, and before a final Office Action under § 1.113, a Notice of Allowance under § 1.311, or an action that otherwise closes prosecution in the application, and is

- [ ] accompanied by the fee set forth in § 1.17(p), or
- [x] filed with the statement set forth in 37 C.F.R. 1.97(e)(1): That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement; or
- [ ] filed with the statement set forth in 37 C.F.R. 1.97(e)(2): That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement.

[ ] After the periods described above, and is accompanied by the fee set forth in § 1.17(p), and is

- [ ] filed with the statement set forth in 37 C.F.R. 1.97(e)(1), that each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement; or

- [ ] filed with the statement set forth in 37 C.F.R. 1.97(e)(2), that no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement.

[ ] Concurrently with a Request for Continued Examination, and no additional fee is due for this IDS.

Items Disclosed

At least one item listed on the enclosed form PTO-1449 (modified) was

[x] Cited in an Office Action for a related application, the application number of the related application and the issue date of the Office Action are provided below and the Office Action is enclosed.

Please see the enclosed form PTO-1449 (modified) for related application number(s) and issue date(s).

[ ] Cited in an International Search Report (ISR) or an International Preliminary Report on Patentability (IPRP) or a Written Opinion (WO) of the International Searching Authority (ISA) for the related PCT Application, the PCT application number and the issue date of the ISR/IPRP/WO are provided below and the ISR/IPRP/WO is enclosed.

Additional Information

[x] Translations of the foreign-language documents are also enclosed as machine-translations, human-translations, or counterpart applications as noted. Machine translations were provided by the Japanese Patent Office, ESPACENET, Google Documents, Patent Fetcher® /ESPACENET, Google Translate or Google Translator Toolkit as noted and with OCR by Adobe Acrobat 9 or ABBYY PDF Transformer 3 if needed.

[x] English-language abstracts of foreign-language documents are provided.

[x] Documents listed on the enclosed ISR/IPRP/WO or the Office Action have relevance at least as described therein.

[ ] The documents with the following reference numbers were described in the specification of the present application; omission of a reference from this list does not indicate that it was not discussed in the specification of the present application.

[x] At least one of the references cited in the Office Action listed on the attached PTO-1449 (modified) were previously submitted in an IDS or cited by the Examiner for the present application on March 4, 2020 and March 6, 2019 and therefore are not submitted in this IDS.

[x] Other: copy of the statement as set forth under 37 C.F.R. 1.97(e)(1).

I hereby certify that this document is being transmitted to the Patent and Trademark Office via electronic filing.

July 16, 2020
(Date of Transmission)

Azatuhi Chinaryan
(Name of Person Transmitting)

/ Azatuhi Chinaryan /
(Signature)

Respectfully submitted,

/ Young Seok Koo 76,255 /

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/294,883	03/06/2019	Woojin Ahn	B-9905CON 631950-4	6210

158747 7590 06/23/2020

LADAS & PARRY
E-MAIL
4525 Wilshire Boulevard
Suite 240
LOS ANGELES, CA 90010

EXAMINER	
RANDHAWA, MANDISH K	

ART UNIT	PAPER NUMBER
2477	

NOTIFICATION DATE	DELIVERY MODE
06/23/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

LA_MAIL@la.ladas.com
achinaryan@la.ladas.com
ykoo@la.ladas.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 16/294,883	Applicant(s) Ahn et al.	
	Examiner MANDISH RANDHAWA	Art Unit 2477	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 3/6/19.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 21-40 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 21-40 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☑ None of the:

1.☑ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 3/6/19, 9/10/19, 3/4/20.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Claim Rejections - 35 USC § 103

2. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

3. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

6. Claims 21-23, 26-28, 33-35 and 38-40 are rejected under 35 U.S.C. 103 as being unpatentable over Cherian et al. (US 2017/0325264 A1, hereinafter "Cherian") in view of IEEE 802.11-16/1180r0 ("Proposed spec text for MU EDCA parameters").

Regarding claims 21, 22, 33 and 34, Cherian teaches a wireless communication terminal that wirelessly communicates with a base wireless communication terminal, the wireless communication terminal comprising: a transceiver; and a processor (**figs. 1 and 2**), wherein the processor is configured to: transmit, to the base wireless communication terminal, a trigger-based physical layer protocol data unit (PPDU) using the transceiver (**Provisional application No. 62/333745: figs. 3, 4, ¶ [0047], Once the STA receives a trigger frame scheduling UL resources, the STA may switch to the MU mode and transmit data packets using the scheduled resources, ¶ [0049], ¶ [0065]**); switch a parameter set, which is a set of parameters used for the channel access, from a first parameter set to a second parameter set based on whether the base wireless communication terminal triggers a multi-user uplink transmission participation of the wireless communication terminal (**Provisional application No. 62/333745: ¶ [0052]-¶ [0054], ¶ [0058], One or more of the STAs may be operating in a default SU**

mode before receiving the trigger frame from the AP. In response to receiving the trigger frame at 402, the STAs 1-3 transition to the MU mode and, simultaneously transmit packets on the UL on resources scheduled by the trigger frame received at 402., Fig. 5, ¶ [0061], The most recent MU EDCA Parameter Set element received by a STA may be used to update the appropriate MIB values. ¶ [0065] A High Efficiently (HE) non-AP STA that receives a trigger frame (e.g., Basic variant Trigger frame) that contains a Per User Info field with the AID of the STA may update its EDCA parameters, for example, dotIIEDCATableCWmin, dotI IEDCATableCWmax, dotIIEDCATableAIFSN, and dotI IHEMUEDCATimer to the values contained in the most recently received MU EDCA Parameter Set element sent by the AP to which the STA is associated. In an aspect, the dotI IHEMUEDCATimer may uniformly count down to 0 when its value is nonzero.); set a second parameter set timer; when the second parameter set timer expires, terminate an application of the second parameter set (**Provisional application No. 62/333745: Fig. 5, ¶ [0063], where The MU EDCA Timer indicates the duration of time, in units of TUs, for which the provided MU EDCA parameters are valid after reception of a Trigger frame, ¶ [0065] An HE non-AP STA that receives a trigger frame (e.g., Basic variant Trigger frame) that contains a Per User Info field with the AID of the STA may update its EDCA parameters sent by the AP to which the STA is associated. In an aspect, the dotI IHEMUEDCATimer may uniformly count down to 0 when its value is nonzero, ¶ [0067], ¶ [0069]**), access a channel according to a priority of data to be transmitted to the base communication terminal by the wireless communication terminal and the parameter set; and transmitting the data through the channel (**Provisional application No. 62/333745: figs.3- 5, ¶ [0042]**).

Cherian does not explicitly teach set a second parameter set timer based on whether a response to a MAC protocol data unit (MPDU) included in the trigger-based PPDU is received.

IEEE teaches set a second parameter set timer based on whether a response to an MPDU included in the trigger-based PPDU is received; wherein the processor is configured to set the second parameter set timer when the response reception ends (**Pages 5-6, The STA operating with MU EDCA parameters can switch back to the legacy EDCA parameters: if the STA has not been scheduled after a pre-defined TimeOut after the last time the STA was scheduled by Basic variant Trigger frame in UL MU. Timeout starts from end of basic variant Trigger. The MU EDCA Timer indicates the duration of time, in units of 8TUs, for which the provided MU EDCA parameters are used by an HE STA after reception of a basic variant Trigger frame. Page 7: An HE non-AP UL MU capable STA that receives a Basic variant Trigger frame that contains a Per User Info field with the AID of the STA, and that receives an immediate response from the AP for the transmitted Trigger-based PPDU, shall: ...Update its HEMUEDCATimer state variable to the values contained in the most recently received MU EDCA Parameter Set element sent by the AP to which the STA is associated. The HEMUEDCATimer shall uniformly count down to 0 when its value is nonzero**).

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to set a second parameter set timer based on whether a response to an MPDU included in the trigger-based PPDU is received in the system of Cherian to comply with the IEEE standard requirements.

Regarding claims 23 and 35, Cherian in view of IEEE teaches the wireless communication terminal of claim 21.

Cherian does not explicitly teach wherein the processor is configured to set the second parameter set timer for an access category of an MPDU for which the response is received.

IEEE teaches wherein the processor is configured to set the second parameter set timer for an access category of an MPDU for which the response is received (**Page 7: An HE non-AP UL MU capable STA that receives a Basic variant Trigger frame that contains a Per User Info field with the AID of the STA, and that receives an immediate response from the AP for the transmitted Trigger-based PPDU, shall: update its CWmin[AC], CWmax[AC], AIFSN[AC], state variables to the values contained in the most recently received MU EDCA Parameter Set element sent by the AP to which the STA is associated, for all the ACs from which QoS Data frames were transmitted in the trigger-based PPDU. Update its HEMUEDCATimer state variable to the values contained in the most recently received MU EDCA Parameter Set element sent by the AP to which the STA is associated**).

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to configured to set the second parameter set timer for an access category of an MPDU for which the response is received in the system of Cherian in view of IEEE to comply with the IEEE standard requirements.

Regarding claims 26 and 38, Cherian in view of IEEE teaches the wireless communication terminal of claim 21, wherein the MPDU included in the trigger-based PPDU is a QoS data frame (**Provisional application No. 62/333745: ¶ [0042] and ¶ [0060]. IEEE: Pages 5-7, An HE non-AP UL MU capable STA that receives a Basic**

variant Trigger frame that contains a Per User Info field with the AID of the STA, and that receives an immediate response from the AP for the transmitted Trigger-based PPDU, shall: update its CWmin[AC], CWmax[AC], AIFSN[AC], state variables to the values contained in the most recently received MU EDCA Parameter Set element sent by the AP to which the STA is associated, for all the ACs from which QoS Data frames were transmitted in the trigger-based PPDU.).

Regarding claims 27 and 39, Cherian in view of IEEE teaches the wireless communication terminal of claim 21.

Cherian does not explicitly teach wherein the processor is configured to receive a beacon frame from the base wireless communication terminal and obtain information indicating a period of the second parameter set timer from the beacon frame.

IEEE teaches wherein the processor is configured to receive a beacon frame from the base wireless communication terminal and obtain information indicating a period of the second parameter set timer from the beacon frame (**Pages 6-7, The QoS AP shall announce the EDCA parameters in selected Beacon frames**).
Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to receive a beacon frame from the base wireless communication terminal and obtain information indicating a period of the second parameter set timer from the beacon frame in the system of Cherian in view of IEEE to comply with the IEEE standard requirements.

Regarding claims 28 and 40, Cherian in view of IEEE teaches the wireless communication terminal of claim 21, wherein when switching the parameter set from the first parameter set to the second parameter set, the processor is configured to set the second parameter set timer (**Provisional application No. 62/333745: ¶ [0058], One or**

more of the STAs may be operating in a default SU mode before receiving the trigger frame from the AP. In response to receiving the trigger frame at 402, the STAs 1-3 transition to the MU mode and, simultaneously transmit packets on the UL on resources scheduled by the trigger frame received at 402., Fig. 5, ¶ [0061], The most recent MU EDCA Parameter Set element received by a STA may be used to update the appropriate MIB values. ¶ [0065] A High Efficiently (HE) non-AP STA that receives a trigger frame (e.g., Basic variant Trigger frame) that contains a Per User Info field with the AID of the STA may update its EDCA parameters, for example, dotIIEDCATableCWmin, dotIIEDCATableCWmax, dotIIEDCATableAIFSN, and dotIIHEMUEDCATimer to the values contained in the most recently received MU EDCA Parameter Set element sent by the AP to which the STA is associated. IEEE: Pages 6-7, The MU EDCA Timer indicates the duration of time, in units of 8TUs, for which the provided MU EDCA parameters are used by an HE STA after reception of a basic variant Trigger frame).

7. Claims 21, 22, 24, 25, 33, 34, 36 and 37 are rejected under 35 U.S.C. 103 as being unpatentable over Cherian in view of Zhou et al. (US 2017/0202023 A1, hereinafter "Zhou").

Regarding claims 21, 22, 33 and 34, Cherian teaches a wireless communication terminal that wirelessly communicates with a base wireless communication terminal, the wireless communication terminal comprising: a transceiver; and a processor (**figs. 1 and 2**), wherein the processor is configured to: transmit, to the base wireless communication terminal, a trigger-based physical layer protocol data unit (PPDU) using the transceiver (**Provisional application No. 62/333745: figs. 3, 4, ¶ [0047], Once the STA receives a trigger frame scheduling UL resources, the STA may switch to the MU mode and**

transmit data packets using the scheduled resources, ¶ [0049], ¶ [0065]); switch a parameter set, which is a set of parameters used for the channel access, from a first parameter set to a second parameter set based on whether the base wireless communication terminal triggers a multi-user uplink transmission participation of the wireless communication terminal (**Provisional application No. 62/333745: ¶ [0052]-¶ [0054], ¶ [0058], One or more of the STAs may be operating in a default SU mode before receiving the trigger frame from the AP. In response to receiving the trigger frame at 402, the STAs 1-3 transition to the MU mode and, simultaneously transmit packets on the UL on resources scheduled by the trigger frame received at 402., Fig. 5, ¶ [0061], The most recent MU EDCA Parameter Set element received by a STA may be used to update the appropriate MIB values. ¶ [0065] A High Efficiently (HE) non-AP STA that receives a trigger frame (e.g., Basic variant Trigger frame) that contains a Per User Info field with the AID of the STA may update its EDCA parameters, for example, dotIIEDCATableCWmin, dotI IEDCATableCWmax, dotIIEDCATableAIFSN, and dotI IHEMUEDCATimer to the values contained in the most recently received MU EDCA Parameter Set element sent by the AP to which the STA is associated. In an aspect, the dotI IHEMUEDCATimer may uniformly count down to 0 when its value is nonzero.**); set a second parameter set timer; when the second parameter set timer expires, terminate an application of the second parameter set (**Provisional application No. 62/333745: Fig. 5, ¶ [0063], where The MU EDCA Timer indicates the duration of time, in units of TUs, for which the provided MU EDCA parameters are valid after reception of a Trigger frame, ¶ [0065] An HE non-AP STA that receives a trigger frame (e.g., Basic variant Trigger frame) that contains a Per User Info field with the AID of the STA may update its EDCA parameters sent by the**

AP to which the STA is associated. In an aspect, the dot11HEMUEDCATimer may uniformly count down to 0 when its value is nonzero, ¶ [0067], ¶ [0069]), access a channel according to a priority of data to be transmitted to the base communication terminal by the wireless communication terminal and the parameter set; and transmitting the data through the channel (**Provisional application No. 62/333745: figs.3- 5, ¶ [0042]**).

Cherian does not explicitly teach set a second parameter set timer based on whether a response to a MAC protocol data unit (MPDU) included in the trigger-based PPDU is received.

Zhou teaches set a second parameter set timer based on whether a response to an MPDU included in the trigger-based PPDU is received; wherein the processor is configured to set the second parameter set timer when the response reception ends (**Provisional application No. 62/278,268: ¶ [0081], the STA 106 may reset timer/counter to zero after the STA 106 transmits a scheduled UL transmission, or transmits a scheduled UL transmission and gets an ACK message. In other aspects, the STA 106 may reset timer/counter to zero after the STA 106 transmits a non-scheduled UL transmission, or transmits a non-scheduled UL transmission and gets an ACK message**).

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to set a second parameter set timer based on whether a response to an MPDU included in the trigger-based PPDU is received in the system of Cherian to further improve the system (**¶ [0005] of Zhou**).

Regarding claims 24, 25, 36 and 37, Cherian in view of Zhou teaches the wireless communication terminal of claim 21.

Cherian does not explicitly teach, wherein the processor is configured to determine when to set the second parameter set timer based on a type of responding requested by the MPDU included in the trigger-based PPDU.

However, Zhou teaches the wireless communication terminal may set second parameter timer after the wireless communication terminal transmits a scheduled UL transmission, or transmits a scheduled UL transmission and gets an ACK message (**Provisional application No. 62/278,268: ¶ [0081]**).

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to determine when to set the second parameter set timer based on a type of responding requested by the MPDU included in the trigger-based PPDU (i.e., determine to set the second parameter set timer when the transmission of the trigger-based PPDU ends when the ACK is not requested or to set the second parameter set timer after an ACK is received when the ACK is requested) in the system of Cherian in view of Zhou. The motivation for doing this is a matter of design choice.

8. Claims 29 and 30 are rejected under 35 U.S.C. 103 as being unpatentable over Cherian in view of IEEE as applied to claim 21 above, and further in view of Liu et al. (US 2016/0066257 A1, hereinafter "Liu").

Regarding claim 29, Cherian in view of IEEE teaches the wireless communication terminal of claim 21, wherein the parameter set comprises a minimum value (CWmin) of the Contention Window (CW) and a maximum value (CWmax) of the CW (**Cherian: ¶ [0064] and ¶ [0065]. IEEE: pages 5 and 7**).

Cherian in view of IEEE does not explicitly teach wherein the processor is configured to calculate a random integer value within a CW, set a backoff timer based

on the random integer value, and access the channel based on the back off timer and a predetermined slot time.

However, it is well known in the art to calculate a random integer value within a CW, set a backoff timer based on the random integer value, and access the channel based on the back off timer and a predetermined slot time, wherein the parameter set comprises a CWmin and CWmax of the CW, as evidenced by **¶ [0031]** of Liu.

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to calculate a random integer value within a CW, set a backoff timer based on the random integer value, and access the channel based on the back off timer and a predetermined slot time in the system of Cherian in view of IEEE to comply with EDCA protocol in IEEE 802.11 WLAN (**¶ [0031] of Liu**).

Regarding claim 30, Cherian in view of IEEE teaches the wireless communication terminal of claim 21, wherein the parameter set comprises a minimum value (CWmin) of the Contention Window (CW) and a maximum value (CWmax) of the CW (**Cherian: ¶ [0064] and ¶ [0065]. IEEE: pages 5 and 7**).

Cherian in view of IEEE does not explicitly wherein the processor is configured to calculate a random integer value in a CW, set a backoff timer based on the random integer value, access the channel based on the back off timer and a predetermined slot time, and if a value of the CW is greater than the maximum value (CWmax) of the CW according to a priority of the data to be transmitted, sets the value of the CW to the CWmax.

However, it is well known in the art to calculate a random integer value in a CW, set a backoff timer based on the random integer value, access the channel based on

the back off timer and a predetermined slot time, and if a value of the CW is greater than the CWmax of the CW according to a priority of the data to be transmitted, sets the value of the CW to the CWmax, as evidenced by **¶ [0030] and ¶ [0031]** of Liu.

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to calculate a random integer value in a CW, set a backoff timer based on the random integer value, access the channel based on the back off timer and a predetermined slot time, and if a value of the CW is greater than the maximum value (CWmax) of the CW according to a priority of the data to be transmitted, sets the value of the CW to the CWmax in the system of Cherian in view of IEEE to comply with EDCA protocol in IEEE 802.11 WLAN (**¶ [0031] of Liu**).

9. Claims 31 and 32 are rejected under 35 U.S.C. 103 as being unpatentable over Cherian in view of IEEE as applied to claim 21 above, and further in view of Baron et al (US 2019/0313453 A1, hereinafter "Baron").

Regarding claims 31 and 32, Cherian in view of IEEE teaches the wireless communication terminal of claim 21.

Cherian in view of IEEE does not explicitly teach wherein the processor is configured to operate a plurality of queues that are classified according to an access category of data stored in a queue and performs backoff procedure of accessing a channel based on a time corresponding to a backoff timer in each of the plurality of queues, and when there is no data stored in the queue and the backoff timer corresponding to the queue is 0, perform no operation at a slot boundary of the backoff timer, wherein the backoff timer is set based on a random integer value calculated in a contention window (CW), and is reduced when the channel is idle for a

predetermined slot time, wherein when there is no data stored in the queue and the backoff timer corresponding to the queue is 0, the processor is configured to maintain the backoff timer to be 0.

Baron teaches wherein the processor is configured to operate a plurality of queues that are classified according to an access category of data stored in a queue and performs backoff procedure of accessing a channel based on a time corresponding to a backoff timer in each of the plurality of queues, and when there is no data stored in the queue and the backoff timer corresponding to the queue is 0, perform no operation at a slot boundary of the backoff timer, wherein the backoff timer is set based on a random integer value calculated in a contention window (CW), and is reduced when the channel is idle for a predetermined slot time, wherein when there is no data stored in the queue and the backoff timer corresponding to the queue is 0, the processor is configured to clear the backoff timer (**¶ [0159], ¶ [0160], each AC (and corresponding buffer) acts as an independent DCF contending entity including its respective queue backoff engine, ¶ [0107], the queue backoff value associated with a non-empty traffic queue being decreased by the node over time to access the communication channel upon reaching zero. Of course, this operation may be made for each traffic queue that becomes empty after the step of transmitting data. clearing a queue backoff value corresponding to a traffic queue when no more data to be transmitted to the access point, ¶ [0262], [0262] The node then computes the queue backoff value as being equal to a random value selected in range [0, CW]+AIFS, where CW is the current value of the CW for the Access Category**).

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was filed to operate a plurality of queues that are classified according to

an access category of data stored in a queue and perform backoff procedure of accessing a channel based on a time corresponding to a backoff timer, set based on a random integer value calculated in a contention window (CW), and reduced when the channel is idle for a predetermined slot time, in each of the plurality of queues, and perform no operation at a slot boundary of the backoff timer and to maintain the backoff timer to be 0 when there is no data stored in the queue and the backoff timer corresponding to the queue is 0 in the system of Cherian in view of IEEE to provide improved and fairer communication method/device (**¶ [0042] of Baron**).

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MANDISH RANDHAWA whose telephone number is (571)270-5650. The examiner can normally be reached on Monday-Thursday (7 AM-4 PM).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ayaz Sheikh can be reached on (571) 272-3795. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR.

Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MANDISH K RANDHAWA/
Examiner, Art Unit 2477

Notice of References Cited	Application/Control No. 16/294,883	Applicant(s)/Patent Under Reexamination Ahn et al.	
	Examiner MANDISH RANDHAWA	Art Unit 2477	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20170325264-A1	11-2017	CHERIAN; George	H04W74/0816	1/1
*	B	US-20170202023-A1	07-2017	Zhou; Yan	H04W72/12	1/1
*	C	US-20160066257-A1	03-2016	Liu; Jianhan	H04L5/006	370/329
*	D	US-20190313453-A1	10-2019	BARON; Stephane	H04W74/0816	1/1
	E					
	F					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	IEEE 802.11-16/1180r0 ("Proposed spec text for MU EDCA parameters"), September 2016. (Year: 2016)
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/294,883	Ahn et al.
	Examiner	Art Unit
	MANDISH RANDHAWA	2477

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/18/2020								
	21	✓								
	22	✓								
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	39	✓								
	40	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/294,883	Ahn et al.
	Examiner	Art Unit
	MANDISH RANDHAWA	2477

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Performed Inventor/Double Patenting search	06/17/2020	MR
Performed NPL (IP.com, STIC, Google), and East text search	06/18/2020	MR

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Form PTO-1449 (Modified) Page 1 of 1	ATTY DOCKET NO. B-9905CON 631950-4	U.S. SERIAL NO. 16/294,883
LIST OF PATENTS AND PUBLICATIONS STATEMENT	APPLICANT WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC. & SK TELECOM CO., LTD.	FILING DATE OR 371 (C) DATE March 6, 2019
		GROUP NO. 2477

U.S. PATENT DOCUMENTS

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT NUMBER	ISSUE/PUBL. DATE	NAME	CLASS	SUB-CLASS	REMARKS

FOREIGN PATENT DOCUMENTS

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT NUMBER	PUBLICATION DATE	COUNTRY	CLASS	SUB-CLASS	TRANSLATION
	1.	2018-509024	Mar. 29, 2018	JP			Espacenet
	2.	2016/007770	Jan. 14, 2016	WO			
	3.	2016/068572	May 6, 2016	WO			Espacenet

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT
	4.	Office Action dated December 16, 2019 for Japanese Patent Application No. 2019-534619 and its English translation provided by the Applicant's foreign counsel
	5.	Office Action dated February 3, 2020 for Japanese Patent Application No. 2019-500497 and its English translation provided by the Applicant's foreign counsel
	6.	Extended European Search Report dated February 10, 2020 for European Patent Application No. 17824568.4
	7.	Laurent Cariou et al. "2 Sets of EDCA Parameters", IEEE 802.11-16/0998r0, IEEE, July 2016, Search Date December 5, 2019, Internet URL: https://mentor.ieee.org/802.11/dcn/16/11-16-0998-00-00ax-rules-for-2-edcaparameters.pptx >. Slides 1-21
	8.	Robert Stacey, "Specification Framework for TGax", IEEE 802.11-15/0132r17, IEE P802.11. Internet URL: https://mentor.ieee.org/802. 11/dcn/15/11-15-0132-17-00ax-spec-framework.docx>, May 25, 2016, pp. 33-34
	9.	Chittabrata Ghosh (INTEL): "Signaling of Multi-TID Aggregation Limit", IEEE 802.11-16/0667r0, Draft: 11-16-0667-00-00AX-SIGNALING-OF-MULTI-TID-AGGREGATION-LIMIT, IEEE-SA MENTOR, Piscataway, NJ USA, vol. 802.11ax, May 16, 2016, pages 1-16, XP068119549, Internet URL: https://mentor.ieee.org/802.11/dcn/16/11-16-0667-00-00ax-signaling-of-multi-tid-aggregation-limit.pptx (retrieved on 05/16/2016)
	10.	Chittabrata Ghosh (INTEL): "Multi-TID Aggregation Limit", IEEE 802.11-16/0362r1, Draft: 11-16-0362-01-00AX-MULTI-TID-AGGREGATION-LIMIT, IEEE-SA MENTOR, Piscataway, NJ USA, vol. 802.11ax, No. 1, May 15, 2016, pages 1-26, XP068105245, Internet URL: https://mentor.ieee.org/802.11/dcn/16/11-16-0667-00-00ax-signaling-of-multi-tid-aggregation-limit.pptx (retrieved on 03/15/2016)

ALL REFEREN

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	11.	LAN/MAN STANDARDS COMMITTEE OF THE IEEE COMPUTER SOCIETY; "Draft Standard for Information technology-tele-communications and information exchange between systems Local and metropolitan area networks- Specific requirements, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for high efficiency in frequency bands between 1 GHz and 6Ghz", IEEE Draft; Draft P802.11ax_D0.2, IEEE-SA, Piscataway, NJ USA, vol. 802.11ax drafts, no. D0.2, June 8, 2016. Pages 1-227, XP068137424, Retrieved from the Internet: URL: www.ieee802.org/11/private/Draft_Standards/11ax/Draft P802.11ax_D0.2.pdf (Retrieved on June 8, 2016)

EXAMINER	*DATE CONSIDERED*
/MANDISH K RANDHAWA/	06/18/2020

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. sInclude copy of this form with next communication to applicant.

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Form PTO-1449 (Modified) Page 1 of 1	ATTY DOCKET NO. B-9905CON 631950-4	U.S. SERIAL NO. 16/294,883
LIST OF PATENTS AND PUBLICATIONS STATEMENT	APPLICANT WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC. and SK TELECOM CO., LTD.	FILING DATE OR 371 (C) DATE March 6, 2019
		GROUP NO. ~~2464~~ 2477

U.S. PATENT DOCUMENTS

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT NUMBER	ISSUE/PUBL. DATE	NAME	CLASS	SUB-CLASS	REMARKS
	1.	2017/0257196	Sept. 7, 2017	Ghosh et al.			
	2.	2017/0310446	Oct. 26, 2017	ASTERJADHI et al.			
	3.	2016/0080115	Mar. 17, 2016	Joshiam et al.			
	4.	2015/0124690	May 7, 2015	MERLIN et al.			
	5.	2017/0272138	Sep. 21, 2017	CHUN et al.			
	6.	2017/0303280	Oct. 19, 2017	CHUN et al.			
	7.	2017/0289911	Oct. 5, 2017	KIM et al.			

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EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT NUMBER	PUBLICATION DATE	COUNTRY	CLASS	SUB-CLASS	TRANSLATION

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT
	8.	International Preliminary Report on Patentability (Chapter I) issued on March 12, 2019 for PCT/KR2017/009841 and its English translation from WIPO
	9.	Notice of Allowance dated July 10, 2019 for U.S. Patent Application No. 16/233,078
	10.	Non-Final Office Action dated March 18, 2019 for U.S. Patent Application No. 16/233,078

EXAMINER	*DATE CONSIDERED*
/MANDISH K RANDHAWA/	06/18/2020

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EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	603	(CW$1min or (minimum or min) near CW) same ((maximum or max) cw or CW$1max) same (back$off with random)	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 12:03
L2	502	(CW$1min or (minimum or min) near CW) same ((maximum or max) cw or CW$1max) same (back$off with random with (integer or value))	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 12:04
L3	499	(contention window) and (CW$1min or (minimum or min) near CW) same ((maximum or max) cw or CW$1max) same (back$off with random with (integer or value))	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 12:05
L4	472	(contention window with "cw") and (CW$1min or (minimum or min) near CW) same ((maximum or max) cw or CW$1max) same (back$off with random with (integer or value))	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 12:05
L5	52	(contention window with "cw") and (CW$1min or (minimum or min) near CW) same ((maximum or max) cw or CW$1max) same (back$off with random with (integer or value)) same (access with channel)	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 12:06
L6	158	(access category or "ac") with (queue) same back$off with queue	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 13:26
L7	104	(access category or "ac") with (queue) same back$off with queue and back$off with (zero or "0")	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 13:33
L8	12	(access category or "ac") with (queue) same back$off with queue and back$off with (zero or "0") same (empty or "no" (data or packet)) near2 queue	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/18 13:43
L10	7	("20150124690"|"20160080115"|"20170257196"|"20170272138"|"20170289911"|"20170303280"|"20170310446").PN.	US-PGPUB; USPAT	NEAR	ON	2020/06/18 14:38
S1	1	"16294883"	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 12:20
S2	6	(("20160198500") or ("20160113034") or ("20180124826")).PN.	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2020/06/17 12:20
S3	51	mu$2 near edca	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 12:21

EAST Search History (Prior Art)

S4	86	mu$2 near2 edca	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 12:21
S5	40	mu$2 near2 edca same parameter	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 12:22
S6	19	trigger$4 same edca same parameter same timer	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 13:14
S7	187	(mu$2 or multi$2 user) same (parameter or edca) same (timer or time$out) with (respons or feedback or ack or acknowledg$5)	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 14:49
S8	3	"20170202023"	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 14:59
S9	3	("20170245261"|"20190098565"|"9439219").PN.	US-PGPUB; USPAT	NEAR	ON	2020/06/17 16:33
S10	218	(mu$2 or multi$2 user) same trigger and (parameter or edca) same (timer or time$out) with (respons or feedback or ack or acknowledg$5)	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 16:59
S11	21	(mu$2 or multi$2 user) same trigger and (parameter or edca) same (re$1set$4 or set$4) near4 (timer or time$out) with (respons or feedback or ack or acknowledg$5)	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 17:00
S12	3	("802.11ax" or "802.11" ax) same edca same timer	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 17:07
S13	7	(mu$2 or multi$2 user) same trigger and (edca) same (re$1set$4 or set$4 or updat$4) near4 (timer or time$out) with (respons or feedback or ack or acknowledg$5)	US-PGPUB; USPAT; DERWENT	NEAR	ON	2020/06/17 22:28

Form PTO-1449 (Modified) Page 1 of 1	ATTY DOCKET NO. B-9905CON 631950-4	U.S. SERIAL NO. ~~N/A~~ 16/294,883
LIST OF PATENTS AND PUBLICATIONS STATEMENT	APPLICANT WILUS INSTITUTE OF STANDARDS AND TECHNOLOGY INC. et al.	FILING DATE ~~Concurrently Herewith~~ 3/6/19
		GROUP NO. ~~N/A~~ 2477

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EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT NUMBER	ISSUE/PUBL. DATE	NAME	CLASS	SUB-CLASS	REMARKS
	1.	2016/0057657	Feb. 25, 2016	SEOK			
	2.	2010/0150116	Jun. 17, 2010	Ji et al.			

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	3.	10-2015-0073165	Jun. 30, 2015	KR			KIPRIS
	4.	2016/112146	Jul. 14, 2016	WO			
	5.	10-2016-0045023	Apr. 26, 2016	KR			KIPRIS
	6.	2018/048229	Mar. 15, 2018	WO			Espacenet

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EXAMINER INITIAL	REFERENCE NUMBER	DOCUMENT
	7.	International Search Report for PCT/KR2017/009841 mailed on January 9, 2018 and its English translation from WIPO (now published as WO 2018/048229)
	8.	Written Opinion of the International Searching Authority for PCT/KR2017/009841 mailed on January 9, 2018 and its English translation by Google Translate (now published as WO 2018/048229)
	9.	Laurent Cariou et al., "Motivation: Improving HE STAs UL performance", IEEE 802.11-16/0998r0, July 2016, Slides 1-21 created on created on July 25, 2016
	10.	Laurent Cariou et al., "Motivation: Improving HE STAs UL performance", IEEE 802.11-16/0998r1, July 2016, Slides 1-33 created on July 25, 2016
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Application No: 16/294,883

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /MANDISH K RANDHAWA/ Examiner's Signature | Initials

Title: WIRELESS COMMUNICATION METHOD USING ENHANCED DISTRIBUTED CHANNEL ACCESS, AND WIRELESS COMMUNICATION TERMINAL USING SAME

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/06/2019	370	2477	B-9905CON 631950-4
RULE			

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CONTINUING DATA

This application is a CON of PCT/KR2017/009841 09/07/2017

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U.S. PATENT DOCUMENTS

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FOREIGN PATENT DOCUMENTS

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	1.	2018-509024	Mar. 29, 2018	JP			Espacenet
	2.	2016/007770	Jan. 14, 2016	WO			
	3.	2016/068572	May 6, 2016	WO			Espacenet

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	4.	Office Action dated December 16, 2019 for Japanese Patent Application No. 2019-534619 and its English translation provided by the Applicant's foreign counsel
	5.	Office Action dated February 3, 2020 for Japanese Patent Application No. 2019-500497 and its English translation provided by the Applicant's foreign counsel
	6.	Extended European Search Report dated February 10, 2020 for European Patent Application No. 17824568.4
	7.	Laurent Cariou et al. "2 Sets of EDCA Parameters", IEEE 802.11-16/0998r0, IEEE, July 2016, Search Date December 5, 2019, Internet URL: https://mentor.ieee.org/802.11/dcn/16/11-16-0998-00-00ax-rules-for-2-edcaparameters.pptx >. Slides 1-21
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	9.	Chittabrata Ghosh (INTEL): "Signaling of Multi-TID Aggregation Limit", IEEE 802.11-16/0667r0, Draft: 11-16-0667-00-00AX-SIGNALING-OF-MULTI-TID-AGGREGATION-LIMIT, IEEE-SA MENTOR, Piscataway, NJ USA, vol. 802.11ax, May 16, 2016, pages 1-16, XP068119549, Internet URL: https://mentor.ieee.org/802.11/dcn/16/11-16-0667-00-00ax-signaling-of-multi-tid-aggregation-limit.pptx (retrieved on 05/16/2016)
	10.	Chittabrata Ghosh (INTEL): "Multi-TID Aggregation Limit", IEEE 802.11-16/0362r1, Draft: 11-16-0362-01-00AX-MULTI-TID-AGGREGATION-LIMIT, IEEE-SA MENTOR, Piscataway, NJ USA, vol. 802.11ax, No. 1, May 15, 2016, pages 1-26, XP068105245, Internet URL: https://mentor.ieee.org/802.11/dcn/16/11-16-0667-00-00ax-signaling-of-multi-tid-aggregation-limit.pptx (retrieved on 03/15/2016)

	11.	LAN/MAN STANDARDS COMMITTEE OF THE IEEE COMPUTER SOCIETY; "Draft Standard for Information technology-tele-communications and information exchange between systems Local and metropolitan area networks- Specific requirements, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for high efficiency in frequency bands between 1 GHz and 6Ghz", IEEE Draft; Draft P802.11ax_D0.2, IEEE-SA, Piscataway, NJ USA, vol. 802.11ax drafts, no. D0.2, June 8, 2016. Pages 1-227, XP068137424, Retrieved from the Internet: URL: www.ieee802.org/11/private/Draft_Standards/11ax/Draft P802.11ax_D0.2.pdf (Retrieved on June 8, 2016)

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Bibliographic data: JP2018509024 (A) — 2018-03-29

STATION CONTENTION BEHAVIOR IN UPLINK MULTIPLE USER PROTOCOLS

Inventor(s): メルリン、シモーネ, ; ディン、ガン

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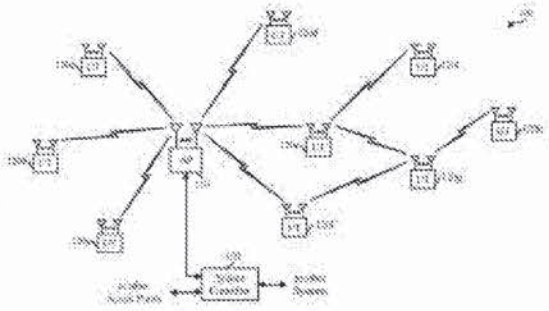
Classification: - international: *H04W74/08; H04W84/12*
- cooperative: **H04W74/08 (US); H04W74/0816 (EP, CN, KR, US); H04W76/11 (EP, KR, US);** H04W72/121 (EP, US); H04W84/12 (EP, US)

Application number: JP20170535911 20160107 Global Dossier

Priority number(s): US201562100859P 20150107 ; US201614989302 20160106 ; WO2016US12407 20160107

Also published as: AU2016205258 (A1) AU2016205258 (B2) BR112017014508 (A2) CN107113887 (A) EP3243357 (A1) more

Abstract not available for JP2018509024 (A)
Abstract of corresponding document: US2016198500 (A1)



Certain aspects of the present disclosure relate to station backoff behavior in uplink (UL) multiple user (MU) operations. Certain aspects of the present disclosure provide an apparatus for wireless communications. The apparatus generally includes a processing system configured to generate an unsolicited single user (SU) frame for transmission to an access point (AP) while the apparatus is configured to communicate with the AP via MU transmissions and a transmit interface configured to output the unsolicited SU frame for transmission. Certain aspects of the present disclosure provide another apparatus for wireless communications. The apparatus generally includes a processing system configured to contend for access to a medium by generating a first frame to trigger MU transmissions from a plurality of apparatuses and a transmit interface configured to output the first frame for transmission.

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CLAIMS JP2018509024

1.

Apparatus for wireless communication, wherein said apparatus is configured to communicate with an access point (AP) via multi-user (MU) communication while a single user (SU) for transmission to said AP Generating a frame and performing a medium access procedure according to a first set of extended distributed channel access (EDCA) parameters while the device is configured to communicate with the AP via MU communication, A contention system for competing for access to the medium for transmission of the SU frame; and outputting the SU frame for transmission when the medium is acquired. A first interface configured.

2.

The first set of EDCA parameters is a second set of EDCA parameters used to contend for access to the medium when the device is not configured to communicate with the AP via MU communication. The device of claim 1, wherein the device is different from the set.

3.

The apparatus of claim 3, further comprising a second interface configured to obtain the first set of EDCA parameters and the second set of EDCA parameters from the AP.

4.

The apparatus of claim 2, wherein the processing system is further configured to adjust the first set of EDCA parameters in response to detecting one or more conditions associated with MU communication. .

5.

The processing system will be the same as the second set of EDCA parameters used to compete for access to the medium when the device is not configured to communicate with the AP via MU communication The apparatus of claim 5, wherein the apparatus is configured to adjust the first set of EDCA parameters by setting the first set of EDCA parameters.

6.

The apparatus of claim 1, wherein the SU frame comprises a data frame, a data frame having a transmission opportunity (TXOP) request, a frame having queue status information, or a control frame indicating a TXOP request.

7.

The second interface further configured to obtain a SU transmission opportunity (TXOP) grant, a MU TXOP grant, or an acknowledgment (ACK) frame after the SU frame has been output for transmission. An apparatus according to claim 1.

8.

8. The ACK frame comprises an indication of the timing of transmission of a frame sent from the AP to trigger a MU transmission from at least one of the device or one or more other devices. An apparatus according to claim 1.

9.

And further comprising a second interface configured to obtain a trigger frame from the AP configured to trigger a MU transmission from at least one of the device or one or more other devices. The apparatus of claim 1.

10.

The trigger frame indicates one or more back-off parameters for contention-based access to the medium, and the processing system determines a back-off countdown based on the one or more back-off parameters. The apparatus of claim 10, wherein the apparatus is configured to start a timer.

11.

The processing system is configured to start a backoff countdown timer and maintain the backoff countdown timer regardless of obtaining the trigger frame or successful MU transmission triggered by the trigger frame. An apparatus according to claim 10.

12.

The apparatus of claim 10, wherein the processing system is configured to adjust a backoff countdown based at least in part on a success or failure of a MU transmission triggered by the trigger frame.

13.

The apparatus of claim 10, wherein the processing system is configured to increase a contention window for accessing the medium for SU transmission if a MU transmission triggered by the trigger frame is successful. .

14.

The processing system is configured to adjust one or more back-off parameters during the contention seeking access to the medium for transmission of the SU frame, wherein the adjustment is buffered at the device. The apparatus of claim 1, wherein the apparatus is based on an amount of data collected.

15.

The apparatus of claim 15, wherein the processing system is configured to adjust a contention window size if the amount of data buffered in the apparatus is equal to or exceeds a threshold.

16.

A second frame configured to obtain one or more trigger frames from the AP configured to trigger a MU transmission from at least one of the device or one or more other devices. Wherein the processing system is configured to adjust one or more backoff parameters during the conflict seeking access to the medium for transmission of the SU frame. The apparatus of claim 1, based on a frequency of the one or more trigger frames obtained from the AP.

17.

The processing system is configured to adjust one or more back-off parameters during the contention seeking access to the medium for transmission of the SU frame, wherein the adjustment is a length of the SU frame. Apparatus according to claim 1, based on the following.

18.

An apparatus for wireless communication, comprising: generating a first frame to trigger a multi-user (MU) transmission from a plurality of devices; and transmitting at least one single-user (SU) frame. One or more other frames to indicate a first set of Enhanced Distributed Channel Access (EDCA) parameters for use in accessing the medium to one or more of the plurality of devices. Generating a first frame for transmission; outputting the one or more other frames for transmission; and a processing system configured to generate the first frame for transmission. A first interface configured to perform the following.

19.

The apparatus of claim 19, wherein the first interface is configured to periodically output the first frame for transmission.

20.

A second interface configured to obtain one or more frames having an indication that one or more of the plurality of devices has buffered data, wherein the processing system further comprises: 20. The apparatus of claim 19, wherein the apparatus is configured to generate the first frame in response to the indication.

21.

The apparatus of claim 21, wherein the one or more obtained frames comprise SU frames.

22.

The apparatus of claim 22, wherein the SU frame comprises at least one of a data frame, a data frame having a transmission opportunity (TXOP) request, a frame having queue status information, or a control frame indicating a TXOP request. .

23.

Acquiring at least one SU frame from one or more of the plurality of devices after the first frame and the one or more other frames are output for transmission. 20. The apparatus of claim 19, further comprising a configured second interface.

24.

A second interface configured to acquire at least one SU frame from one or more of the plurality of devices, wherein the processing system further comprises: the acquired at least one SU frame. 20. The apparatus of claim 19, further configured to generate a SU transmission opportunity (TXOP) grant, a MU TXOP grant, or an acknowledgment (ACK) frame in response to.

25.

The method of claim 1, wherein the first frame comprises one or more backoff parameters for use by one or more of the plurality of devices to contend for access to the medium. 19. The apparatus according to claim 18.

26.

A second interface configured to obtain a frame from one or more of the plurality of devices, wherein the processing system starts a back-off countdown timer based on receiving the obtained frame. The apparatus of claim 19, wherein the apparatus is configured to delay transmission of the first frame based on the backoff countdown timer.

27.

A second interface configured to obtain a frame from the one or more of the plurality of devices, indicating a remaining backoff time associated with one or more of the plurality of devices. Further comprising: determining, based on the remaining back-off time, which of the one or more of the plurality of devices is to be targeted using the first frame. The apparatus of claim 19, wherein the apparatus is configured to:

28.

A method for wireless communication by a device, wherein the device is configured to communicate with an access point (AP) via multi-user (MU) communication while a single user (Generating a SU) frame and performing a medium access procedure according to a first set of extended distributed channel access (EDCA) parameters while the device is configured to communicate with the AP via MU communication. , Competing for access to a medium for transmission of the SU frame, and outputting the SU frame for transmission if the medium is acquired.

29.

The apparatus of claim 1, further comprising: a transmitter through which the SU frame is transmitted, wherein the apparatus is configured as a wireless station.

30.

19. The apparatus of claim 18, further comprising a transmitter through which the first frame and the one or more other frames are transmitted, wherein the apparatus is configured as an access point.

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DESCRIPTION JP2018509024

Abstract Certain aspects of the present disclosure relate to station backoff behavior in uplink (UL) multiple user (MU) operation. Certain aspects of the present disclosure provide an apparatus for wireless communications. The device is generally configured to generate an unsolicited single user (SU) frame for transmission to an access point (AP) while the device is configured to communicate with the AP via an MU transmission. And a transmission interface configured to output SU frames that have not been requested for transmission. Certain aspects of the present disclosure provide another apparatus for wireless communications. The apparatus generally includes a processing system configured to contend for access to the medium by generating a first frame to trigger MU transmissions from the plurality of devices, and a second system for transmission. And a transmission interface configured to output one frame.

[0117] [0125] It will be understood that the claims are not limited to the precise configuration and components illustrated above. Various modifications, changes and variations may be made in the arrangement, operation and details of the methods and apparatus described above without departing from the scope of the claims herein. Hereinafter, the invention described in the claims of the present invention will be additionally described. [C1] A device for wireless communication, wherein the device is configured to communicate with an access point (AP) via multi-user (MU) communication. An apparatus comprising: a processing system configured to generate a single user (SU) frame for transmission to a first interface; and a first interface configured to output the SU frame for transmission. [C2] The processing system of C1, wherein the processing system is configured to contend for access to a medium for transmission of the SU frame according to a first set of extended distributed channel access (EDCA) parameters. Equipment. [C3] The first set of EDCA parameters is an EDCA parameter used for competing for access to the medium when the device is not configured to communicate with the AP via MU communication. The device of C2, wherein the device is different from the second set. [C4] The apparatus of C3, further comprising a second interface configured to obtain the first and second sets of EDCA parameters from the AP. [C5] The processing system of C2, wherein the processing system is further configured to adjust the first set of EDCA parameters in response to detecting one or more conditions associated with MU communication. apparatus. [C6] The processing system includes a second set of EDCA parameters used to compete for access to the medium when the device is not configured to communicate with the AP via MU communication. The apparatus of C5, wherein the apparatus is configured to adjust the first set of EDCA parameters by setting the first set of EDCA parameters to be the same. [C7] The apparatus of C1, wherein the SU frame comprises a data frame, a data frame having a transmission opportunity (TXOP) request, a frame having queue status information, or a control frame indicating a TXOP request.

[C8] The apparatus of C1, further comprising a second interface configured to obtain a SU TXOP grant, a MU TXOP grant, or an acknowledgment (ACK) frame after the transmission of the SU frame. [C9] The device of C8, wherein the ACK frame comprises an indication of the timing of transmission of a frame sent from the AP to trigger MU transmissions from the device and one or more other devices. [C10] The device of C1, further comprising a second interface configured to obtain, from the AP, a trigger frame configured to trigger MU transmissions from the device and one or more other devices. The described device. [C11] The apparatus of C10, wherein the trigger frame indicates one or more backoff parameters for contention-based access to a medium for the device and the one or more devices. [C12] The processing system may start a back-off countdown timer and maintain the back-off countdown timer irrespective of obtaining the trigger frame or regardless of a successful MU transmission triggered

by the trigger frame. The device of C10, wherein the device is configured. [C13] The apparatus of C10, wherein the processing system is configured to adjust a backoff countdown based at least in part on a success or failure of the MU transmission triggered by the trigger frame. [C14] The processing system of C10, wherein the processing system is configured to increase a contention window for accessing the medium for SU transmission if the MU transmission triggered by the trigger frame is successful. apparatus. [C15] The processing system is configured to adjust one or more backoff parameters during a contention for access to a medium for transmission of the SU frame, wherein the adjustment is performed at a buffer at the device. The apparatus of C1, based on the amount of data obtained. [C16] The apparatus of C15, wherein the processing system is configured to adjust a contention window size if the amount of data buffered in the apparatus is equal to or exceeds a threshold. [C17] A second interface configured to obtain one or more trigger frames from the AP configured to trigger MU transmissions from the device and one or more other devices. The processing system is further configured to adjust one or more backoff parameters during a contention for access to a medium for transmission of the SU frame, the adjustment being received from the AP. The apparatus of C1, wherein the apparatus is based on a frequency of the one or more trigger frames.

[C18] The processing system is configured to adjust one or more back-off parameters during a contention for access to the medium for transmission of the SU frame, wherein the adjustment is performed on the SU frame. The device of C1, based on length. [C19] An apparatus for wireless communications, wherein a first frame is generated for competing for access to a medium to trigger a multi-user (MU) transmission from a plurality of apparatuses. An apparatus comprising: a processing system configured; and a first interface configured to output the first frame for transmission. [C20] The apparatus of C19, wherein the processing system is configured to periodically generate a second frame to trigger a MU transmission from the plurality of apparatuses. [C21] a second interface configured to obtain one or more frames having an indication that one or more of the plurality of devices has buffered data; The apparatus of C19, wherein a processing system is configured to generate the first frame in response to the indication. [C22] The apparatus of C21, wherein the one or more obtained frames comprise a single user (SU) frame. [C23] The SU frame according to C22, wherein the SU frame comprises at least one of a data frame, a data frame having a transmission opportunity (TXOP) request, a frame having queue status information, and a control frame indicating a TXOP request. apparatus. [C24] further comprising a second interface configured to obtain at least one single user (SU) frame from one or more of the plurality of devices, wherein the processing system further comprises: Generating one or more frames to indicate to all other devices a first set of Enhanced Distributed Channel Access (EDCA) parameters for use in accessing the medium to send SU frames. The device according to C19, configured as follows. [C25] a second interface configured to acquire at least one single user (SU) frame from one or more of the plurality of devices, wherein the processing system includes: The apparatus of C19, further configured to generate a SU transmission opportunity (TXOP) grant, a MU TXOP grant, or an acknowledgment (ACK) frame in response.

[C26] The processing system is further configured to include one or more backoff parameters for contention-based access to the medium by the plurality of devices in the first frame. The device according to C19. [C27] a second interface configured to acquire a frame from one or more of the plurality of devices, wherein the processing system performs a back-off countdown based on the reception of the acquired frame. The apparatus of C19, configured to start a timer and delay transmission of the first frame based on the backoff countdown timer. [C28] A second configured to obtain a frame from the one or more of the plurality of devices, the frame indicating a remaining back-off time associated with one or more of the plurality of devices. The apparatus of C19, further comprising: a second interface, wherein the processing system is configured to determine which device to target using the first frame based on the remaining backoff time. . [C29] A method for wireless communication by a device, wherein the device is configured to communicate with an access point (AP) via a multi-user (MU) transmission, for transmission to the AP. A method comprising: generating a single user (SU) frame; and outputting the SU frame for transmission. [C30] The method of C29, further comprising competing for access to a medium for transmission of the SU frame according to a first set of extended distributed channel access (EDCA) parameters. [C31] The first set of EDCA parameters is an EDCA parameter used for competing for access to the medium when the device is not configured to communicate with the AP via MU communication. The method of C30, wherein the method is different from the second set. [C32] The method of C31, further comprising obtaining the first and second sets of EDCA parameters from the AP. [C33] The method of C30, further comprising adjusting the first set of EDCA parameters in response to detecting one or more conditions associated with a MU communication. [C34] The coordinating comprises: a second set of EDCA parameters used to compete for access to the medium when the device is not configured to communicate with the AP via MU communication. The method of C33, comprising setting the first set of EDCA parameters to be the same as:

[C35] The method of C29, wherein the SU frame comprises a data frame, a data frame with a transmission opportunity (TXOP) request, a frame with queue status information, or a control frame indicating a TXOP request. [C36] The method of C29, further comprising obtaining a SU TXOP grant, a MU TXOP grant, or an acknowledgment (ACK) frame after the transmission of the SU frame. [C37] The method of C36, wherein the ACK frame comprises an indication of the timing of transmission of a frame sent from the AP to trigger a MU transmission from the device and one or more other devices. [C38] The method of C29, further

comprising obtaining a trigger frame from the AP configured to trigger a MU transmission from the device and one or more other devices. [C39] The method of C38, wherein the trigger frame indicates one or more backoff parameters for contention-based access to a medium for the device and the one or more devices. [C40] further comprising: obtaining a trigger frame or starting a back-off countdown timer regardless of a successful MU transmission triggered by the trigger frame; and maintaining the back-off countdown timer. The method described in C38. [C41] The method of C38, further comprising adjusting a backoff countdown based at least in part on a success or failure of the MU transmission triggered by the trigger frame. [C42] The method of C38, further comprising increasing a contention window for accessing the medium for SU transmission if the MU transmission triggered by the trigger frame is successful. [C43] further comprising adjusting one or more backoff parameters during a contention for access to a medium for transmission of the SU frame, wherein the adjustment comprises an amount of data buffered at the device. The method according to C29, based on [C44] The method of C43, further comprising adjusting a contention window size if the amount of data buffered at the device is equal to or greater than a threshold. [C45] obtaining one or more trigger frames from the AP configured to trigger MU transmissions from the device and one or more other devices; and transmitting the SU frame. Adjusting one or more back-off parameters during a contention for access to the medium, wherein the adjusting is based on a frequency of the one or more trigger frames received from the AP. , C29.

[C46] adjusting the one or more backoff parameters during a contention for access to a medium for transmission of the SU frame, wherein the adjustment is based on a length of the SU frame. The method described in C29. [C47] A method for wireless communication by a device, competing for access to a medium by generating a first frame to trigger a multi-user (MU) transmission from a plurality of devices. And outputting the SU frame for transmission. [C48] The method of C47, further comprising periodically generating a second frame to trigger MU transmissions from the plurality of devices. [C49] obtaining one or more frames having an indication that one or more of the plurality of devices has buffered data; and responding to the indication, The method of C47, further comprising: generating a frame of [C50] The method of C49, wherein the one or more obtained frames comprise single user (SU) frames. [C51] The SU frame according to C50, wherein the SU frame includes at least one of a data frame, a data frame having a transmission opportunity (TXOP) request, a frame having queue status information, or a control frame indicating a TXOP request. Method. [C52] obtaining at least one single user (SU) frame from one or more of the plurality of devices and using the medium to access the medium to send the at least one SU frame; C. generating one or more frames to indicate a first set of enhanced distributed channel access (EDCA) parameters to all other devices. [C53] obtaining at least one single user (SU) frame from one or more of the pluralilly of devices; and responding to the SU frame, SU transmission opportunity (TXOP) permission, MU TXOP permission Or generating an acknowledgment (ACK) frame. [C54] The method of C47, further comprising including, in the first frame, one or more backoff parameters for contention-based access to the medium by the pluralilly of devices.

[C55] acquiring a frame from one or more of the plurality of devices, starting a back-off countdown timer based on reception of the acquired frame, and based on the back-off countdown timer The method of C47, further comprising: delaying transmission of the first frame. [C56] obtaining a frame from the one or more of the plurality of devices indicating a remaining back-off time associated with one or more of the plurality of devices; Determining which device is to be targeted using the first frame based on a backoff time. [C57] An apparatus for wireless communication, wherein the apparatus is configured to communicate with an access point (AP) via multi-user (MU) communication while a single user for transmission to the AP. An apparatus comprising: (SU) means for generating a frame; and means for outputting the SU frame for transmission. [C58] The apparatus of C57, further comprising means for competing for access to a medium for transmission of the SU frame according to a first set of extended distributed channel access (EDCA) parameters. [C59] The first set of EDCA parameters is an EDCA parameter used to compete for access to the medium when the device is not configured to communicate with the AP via MU communication. The device according to C58, wherein the device is different from the second set. [C60] The apparatus of C58, further comprising means for obtaining the first and second sets of EDCA parameters from the AP. [C61] The apparatus of C59, further comprising: means for adjusting the first set of EDCA parameters in response to detecting one or more conditions associated with MU communication. [C62] The means for coordinating comprises: a second one of EDCA parameters used to compete for access to the medium when the device is not configured to communicate with the AP via MU communication. The apparatus according to C61, comprising means for setting the first set of EDCA parameters to be the same as the set of EDCA parameters. [C63] The apparatus of C57, wherein the SU frame comprises a data frame, a data frame having a transmission opportunity (TXOP) request, a frame having queue status information, or a control frame indicating a TXOP request.

[C64] The apparatus of C57, further comprising means for obtaining a SU TXOP grant, a MU TXOP grant, or an acknowledgment (ACK) frame after the transmission of the SU frame. [C65] The device of C64, wherein the ACK frame comprises an indication of the timing of transmission of a frame sent from the AP to trigger a MU transmission from the device and one or more other devices. [C66] The device of C57, further comprising means for obtaining a trigger frame from the AP configured to trigger a MU transmission from the device and one or more other devices. [C67] The device of C66, wherein the trigger frame indicates one or more back-off parameters for contention-based access to a medium for the device and the one or

more devices. [C68] Further comprising means for initiating a back-off countdown timer and maintaining the back-off countdown timer, regardless of obtaining the trigger frame or successful MU transmission triggered by the trigger frame. The device according to C66. [C69] The apparatus of C66, further comprising means for adjusting a backoff countdown based at least in part on a success or failure of the MU transmission triggered by the trigger frame. [C70] The apparatus of C66, further comprising means for increasing a contention window for accessing the medium for SU transmission if the MU transmission triggered by the trigger frame is successful. [C71] further comprising means for adjusting one or more back-off parameters during a contention for access to a medium for transmission of the SU frame, wherein the adjustment comprises data buffered at the device. The apparatus according to C57, based on the amount of the. [C72] The apparatus of C71, further comprising means for adjusting a contention window size if the amount of data buffered in the apparatus is equal to or exceeds a threshold. [C73] means for obtaining from the AP one or more trigger frames configured to trigger MU transmissions from the device and one or more other devices; and transmitting the SU frame. Means for adjusting one or more backoff parameters during a contention for access to the medium for the adjustment of the one or more trigger frames received from the AP. The device of C57, based on the frequency of

[C74] Further comprising means for adjusting one or more back-off parameters during a contention for access to a medium for transmission of the SU frame, wherein the adjusting comprises adjusting a length of the SU frame. The device of C57. [C75] An apparatus for wireless communication for competing for access to a medium by generating a first frame to trigger a multi-user (MU) transmission from a plurality of apparatuses. An apparatus comprising: means; and means for outputting the first frame for transmission. [C76] The device of C75, further comprising means for periodically generating a second frame to trigger MU transmissions from the plurality of devices. [C77] means for obtaining one or more frames having an indication that one or more of the plurality of devices has buffered data; and responsive to the indication. C75. The apparatus of C75, further comprising: means for generating a first frame. [C78] The apparatus of C77, wherein the one or more obtained frames comprise single user (SU) frames. [C79] The SU frame according to C78, wherein the SU frame comprises at least one of a data frame, a data frame having a transmission opportunity (TXOP) request, a frame having queue status information, or a control frame indicating a TXOP request. apparatus. [C80] means for obtaining at least one single user (SU) frame from one or more of the plurality of devices; and accessing the medium to send the at least one SU frame. Means for generating one or more frames to indicate a first set of enhanced distributed channel access (EDCA) parameters for use to all other devices. . [C81] means for acquiring at least one single user (SU) frame from one or more of the plurality of devices; and SU transmission opportunity (TXOP) permission, MU in response to the SU frame. Means for generating a TXOP grant or acknowledgment (ACK) frame. [C82] The apparatus of C75, further comprising means for including one or more backoff parameters for contention-based access to the medium by the plurality of devices in the first frame. .

[C83] means for acquiring a frame from one or more of the plurality of devices; and starting a back-off countdown timer based on the reception of the acquired frame; C75. The apparatus of claim C75, further comprising: means for delaying transmission of the first frame. [C84] means for obtaining a frame from the one or more of the plurality of devices, the frame indicating a remaining back-off time associated with one or more of the plurality of devices; Means for using the first frame to determine which device to target based on a remaining back-off time. [C85] While the device is configured to communicate with an access point (AP) via multi-user (MU) communication, generating a single user (SU) frame for transmission to the AP; Outputting the SU frame for storing a computer readable medium. [C86] competing for access to the medium by generating a first frame to trigger a multi-user (MU) transmission from a plurality of devices; and the first frame for transmission. A computer-readable medium that stores instructions for outputting and for performing. [C87] A station, comprising: at least one antenna; and a single station for transmission to the access point (AP) while the station is configured to communicate with an access point (AP) via multi-user (MU) communication. A station comprising: a processing system configured to generate a user (SU) frame; and a transmitter configured to transmit the SU frame via the at least one antenna. [C88] An access point (AP) comprising: at least one antenna; and seeking access to a medium by generating a first frame to trigger a multi-user (MU) transmission from a plurality of devices. An access point, comprising: a processing system configured to contend with the first frame; and a transmitter configured to transmit the first frame via the at least one antenna.

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(54)【発明の名称】アップリンク複数ユーザプロトコルにおける局競合挙動

(57)【要約】
本開示のある特定の態様は、アップリンク（ＵＬ）複数ユーザ（ＭＵ）動作における局のバックオフ挙動に関する。本開示のある特定の態様は、ワイヤレス通信のための装置を提供する。装置は一般に、装置がＭＵ送信を介してＡＰと通信するように構成される間、アクセスポイント（ＡＰ）への送信のために要請されていないシングルユーザ（ＳＵ）フレームを生成するように構成された処理システムと、送信のために要請されていないＳＵフレームを出力するように構成された送信インターフェースとを含む。本開示のある特定の態様は、ワイヤレス通信のための別の装置を提供する。装置は、一般に、複数の装置からのＭＵ送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するように構成された処理システムと、送信のために第１のフレームを出力するように構成された送信インターフェースとを含む。

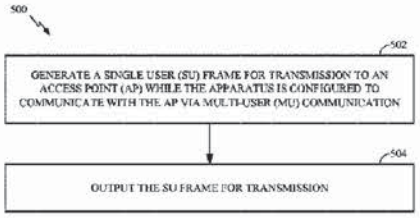


FIG. 5

【特許請求の範囲】
【請求項１】
ワイヤレス通信のための装置であって、
前記装置がマルチユーザ（ＭＵ）通信を介してアクセスポイント（ＡＰ）と通信するように構成される間、前記ＡＰへの送信のためにシングルユーザ（ＳＵ）フレームを生成するように構成された処理システムと、
送信のために前記ＳＵフレームを出力するように構成された第１のインターフェースと
を備える、装置。
【請求項２】
前記処理システムは、拡張分散チャネルアクセス（ＥＤＣＡ）パラメータの第１のセットに従って、前記ＳＵフレームの送信のために、媒体へのアクセスを求めて競合するように構成される、請求項１に記載の装置。
【請求項３】
ＥＤＣＡパラメータの前記第１のセットは、前記装置がＭＵ通信を介して前記ＡＰと通信するように構成されないときに前記媒体へのアクセスを求めて競合するために使用されるＥＤＣＡパラメータの第２のセットとは異なる、請求項２に記載の装置。
【請求項４】
前記ＡＰからＥＤＣＡパラメータの前記第１および第２のセットを取得するように構成された第２のインターフェースをさらに備える、請求項３に記載の装置。
【請求項５】
前記処理システムは、ＭＵ通信に関連した１つまたは複数の条件を検出することに応答して、ＥＤＣＡパラメータの前記第１のセットを調整するようにさらに構成される、
請求項２に記載の装置。
【請求項６】
前記処理システムは、前記装置がＭＵ通信を介して前記ＡＰと通信するように構成されないときに前記媒体へのアクセスを求めて競合するために使用されるＥＤＣＡパラメータの第２のセットと同じになるように、ＥＤＣＡパラメータの前記第１のセットを設定することによって、ＥＤＣＡパラメータの前記第１のセットを調整するように構成される、
請求項５に記載の装置。
【請求項７】
前記ＳＵフレームは、データフレーム、送信機会（ＴＸＯＰ）要求を有するデータフレーム、待ち行列ステータス情報を有するフレーム、またはＴＸＯＰ要求を示す制御フレームを備える、
請求項１に記載の装置。
【請求項８】
前記ＳＵフレームの前記送信の後に、ＳＵ ＴＸＯＰ許可、ＭＵ ＴＸＯＰ許可、または肯定応答（ＡＣＫ）フレームを取得するように構成された第２のインターフェースをさらに備える、請求項１に記載の装置。
【請求項９】
前記ＡＣＫフレームは、前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするために前記ＡＰから送られるフレームの送信のタイミングのインジケーションを備える、請求項８に記載の装置。
【請求項１０】
前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするように構成されたトリガフレームを、前記ＡＰから取得するように構成された第２のインターフェースをさらに備える、請求項１に記載の装置。
【請求項１１】
前記トリガフレームは、前記装置および前記１つまたは複数の装置のために、媒体へのコンテンションベースのアクセスのための１つまたは複数のバックオフパラメータを示す、

請求項１０に記載の装置。
【請求項１２】
前記処理システムは、前記トリガフレームを取得することまたは前記トリガフレームによってトリガされたＭＵ送信の成功には関係なく、バックオフカウントダウンタイマを開始し、前記バックオフカウントダウンタイマを維持するように構成される、請求項１０に記載の装置。
【請求項１３】
前記処理システムは、前記トリガフレームによってトリガされたＭＵ送信の成功または失敗に少なくとも部分的に基づいて、バックオフカウントダウンを調整するように構成される、請求項１０に記載の装置。
【請求項１４】
前記処理システムは、前記トリガフレームによってトリガされたＭＵ送信が成功する場合、ＳＵ送信のために前記媒体にアクセスするためのコンテンションウィンドウを増加させるように構成される、請求項１０に記載の装置。
【請求項１５】
前記処理システムは、前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整するように構成され、前記調整は、前記装置においてバッファされたデータの量に基づく、
請求項１に記載の装置。
【請求項１６】
前記処理システムは、前記装置においてバッファされたデータの前記量が閾値に等しいかまたは閾値を超える場合、コンテンションウィンドウサイズを調整するように構成される、請求項１５に記載の装置。
【請求項１７】
前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするように構成された１つまたは複数のトリガフレームを、前記ＡＰから取得するように構成された第２のインターフェースをさらに備え、
前記処理システムは、前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整するように構成され、前記調整は、前記ＡＰから受信した前記１つまたは複数のトリガフレームの頻度に基づく、
請求項１に記載の装置。
【請求項１８】
前記処理システムは、前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整するように構成され、前記調整は、前記ＳＵフレームの長さに基づく、
請求項１に記載の装置。
【請求項１９】
ワイヤレス通信のための装置であって、
複数の装置からのマルチユーザ（ＭＵ）送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するように構成された処理システムと、
送信のために前記第１のフレームを出力するように構成された第１のインターフェースと
を備える、装置。
【請求項２０】
前記処理システムは、前記複数の装置からのＭＵ送信をトリガするために、第２のフレームを周期的に生成するように構成される、請求項１９に記載の装置。
【請求項２１】
前記複数の装置のうちの１つまたは複数がバッファされたデータを有するとのインジケーションを有する１つまたは複数のフレームを取得するように構成された第２のインター

フェース
をさらに備え、前記処理システムは、前記インジケーションに応答して、前記第１のフレームを生成するように構成される、請求項１９に記載の装置。
【請求項２２】
前記１つまたは複数の取得されたフレームは、シングルユーザ（ＳＵ）フレームを備える、請求項２１に記載の装置。
【請求項２３】
前記ＳＵフレームは、データフレーム、送信機会（ＴＸＯＰ）要求を有するデータフレーム、待ち行列ステータス情報を有するフレーム、またはＴＸＯＰ要求を示す制御フレームのうちの少なくとも１つを備える、
請求項２２に記載の装置。
【請求項２４】
前記複数の装置のうちの１つまたは複数から、少なくとも１つのシングルユーザ（ＳＵ）フレームを取得するように構成された第２のインターフェースをさらに備え、前記処理システムは、前記少なくとも１つのＳＵフレームを送るために前記媒体にアクセスするのに使用するための拡張分散チャネルアクセス（ＥＤＣＡ）パラメータの第１のセットを、他の全ての装置に示すための１つまたは複数のフレームを生成するように構成される、請求項１９に記載の装置。
【請求項２５】
前記複数の装置のうちの１つまたは複数から、少なくとも１つのシングルユーザ（ＳＵ）フレームを取得するように構成された第２のインターフェースをさらに備え、前記処理システムは、前記ＳＵフレームに応答して、ＳＵ送信機会（ＴＸＯＰ）許可、ＭＵ ＴＸＯＰ許可、または肯定応答（ＡＣＫ）フレームを生成するようにさらに構成される、請求項１９に記載の装置。
【請求項２６】
前記処理システムは、前記第１のフレーム内に、前記複数の装置による前記媒体へのコンテンションベースのアクセスのための１つまたは複数のバックオフパラメータを含めるようにさらに構成される、請求項１９に記載の装置。
【請求項２７】
前記複数の装置のうちの１つまたは複数からフレームを取得するように構成された第２のインターフェース
をさらに備え、前記処理システムは、前記取得されたフレームの受信に基づいてバックオフカウントダウンタイマを開始し、前記バックオフカウントダウンタイマに基づいて前記第１のフレームの送信を遅らせるように構成される、請求項１９に記載の装置。
【請求項２８】
前記複数の装置のうちの１つまたは複数に関連付けられた残りのバックオフ時間を示す、前記複数の装置のうちの前記１つまたは複数からのフレームを取得するように構成された第２のインターフェースをさらに備え、前記処理システムは、前記残りのバックオフ時間に基づいて前記第１のフレームを用いてどの装置をターゲットとするかを決定するように構成される、請求項１９に記載の装置。
【請求項２９】
装置によるワイヤレス通信のための方法であって、
前記装置がマルチユーザ（ＭＵ）送信を介してアクセスポイント（ＡＰ）と通信するように構成される間、前記ＡＰへの送信のためにシングルユーザ（ＳＵ）フレームを生成することと、
送信のために前記ＳＵフレームを出力することと
を備える、方法。
【請求項３０】
拡張分散チャネルアクセス（ＥＤＣＡ）パラメータの第１のセットに従って、前記ＳＵフレームの送信のために、媒体へのアクセスを求めて競合することをさらに備える、請求

項２９に記載の方法。
【請求項３１】
ＥＤＣＡパラメータの前記第１のセットは、前記装置がＭＵ通信を介して前記ＡＰと通信するように構成されないときに前記媒体へのアクセスを求めて競合するために使用されるＥＤＣＡパラメータの第２のセットとは異なる、請求項３０に記載の方法。
【請求項３２】
前記ＡＰからＥＤＣＡパラメータの前記第１および第２のセットを取得することをさら備える、請求項３１に記載の方法。
【請求項３３】
ＭＵ通信に関連した１つまたは複数の条件を検出することに応答して、ＥＤＣＡパラメータの前記第１のセットを調整すること
をさらに備える、請求項３０に記載の方法。
【請求項３４】
前記調整することは、
前記装置がＭＵ通信を介して前記ＡＰと通信するように構成されないときに前記媒体へのアクセスを求めて競合するために使用されるＥＤＣＡパラメータの第２のセットと同じになるようにＥＤＣＡパラメータの前記第１のセットを設定すること
を備える、請求項３３に記載の方法。
【請求項３５】
前記ＳＵフレームは、データフレーム、送信機会（ＴＸＯＰ）要求を有するデータフレーム、待ち行列ステータス情報を有するフレーム、またはＴＸＯＰ要求を示す制御フレームを備える、
請求項２９に記載の方法。
【請求項３６】
前記ＳＵフレームの前記送信の後に、ＳＵ ＴＸＯＰ許可、ＭＵ ＴＸＯＰ許可、または肯定応答（ＡＣＫ）フレームを取得することをさらに備える、請求項２９に記載の方法。
【請求項３７】
前記ＡＣＫフレームは、前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするために前記ＡＰから送られるフレームの送信のタイミングのインジケーションを備える、請求項３６に記載の方法。
【請求項３８】
前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするように構成されたトリガフレームを、前記ＡＰから取得することをさらに備える、請求項２９に記載の方法。
【請求項３９】
前記トリガフレームは、前記装置および前記１つまたは複数の装置のために、媒体へのコンテンションベースのアクセスのための１つまたは複数のバックオフパラメータを示す
、
請求項３８に記載の方法。
【請求項４０】
前記トリガフレームを取得することまたは前記トリガフレームによってトリガされたＭＵ送信の成功には関係なく、バックオフカウントダウンタイマを開始すること、および前記バックオフカウントダウンタイマを維持する、をさらに備える、請求項３８に記載の方法。
【請求項４１】
前記トリガフレームによってトリガされたＭＵ送信の成功または失敗に少なくとも部分的に基づいて、バックオフカウントダウンを調整することをさらに備える、請求項３８に記載の方法。
【請求項４２】
前記トリガフレームによってトリガされたＭＵ送信が成功する場合、ＳＵ送信のために

前記媒体にアクセスするためのコンテンションウィンドウを増加させることをさらに備える、請求項３８に記載の方法。
【請求項４３】
前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整することをさらに備え、前記調整は、前記装置においてバッファされたデータの量に基づく、
請求項２９に記載の方法。
【請求項４４】
前記装置においてバッファされたデータの前記量が閾値に等しいかまたは閾値を超える場合、コンテンションウィンドウサイズを調整することをさらに備える、請求項４３に記載の方法。
【請求項４５】
前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするように構成された１つまたは複数のトリガフレームを、前記ＡＰから取得することと、
前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整することと、前記調整は、前記ＡＰから受信した前記１つまたは複数のトリガフレームの頻度に基づく、
をさらに備える、請求項２９に記載の方法。
【請求項４６】
前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整すること
をさらに備え、前記調整は、前記ＳＵフレームの長さに基づく、
請求項２９に記載の方法。
【請求項４７】
装置によるワイヤレス通信のための方法であって、
複数の装置からのマルチユーザ（ＭＵ）送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合することと、
送信のために前記ＳＵフレームを出力することと
を備える、方法。
【請求項４８】
前記複数の装置からのＭＵ送信をトリガするために、第２のフレームを周期的に生成することをさらに備える、請求項４７に記載の方法。
【請求項４９】
前記複数の装置のうちの１つまたは複数がバッファされたデータを有するとのインジケーションを有する１つまたは複数のフレームを取得することと、
前記インジケーションに応答して、前記第１のフレームを生成することと
をさらに備える、請求項４７に記載の方法。
【請求項５０】
前記１つまたは複数の取得されたフレームは、シングルユーザ（ＳＵ）フレームを備える、請求項４９に記載の方法。
【請求項５１】
前記ＳＵフレームは、データフレーム、送信機会（ＴＸＯＰ）要求を有するデータフレーム、待ち行列ステータス情報を有するフレーム、またはＴＸＯＰ要求を示す制御フレームのうちの少なくとも１つを備える、
請求項５０に記載の方法。
【請求項５２】
前記複数の装置のうちの１つまたは複数から、少なくとも１つのシングルユーザ（ＳＵ）フレームを取得することと、
前記少なくとも１つのＳＵフレームを送るために前記媒体にアクセスするのに使用するための拡張分散チャネルアクセス（ＥＤＣＡ）パラメータの第１のセットを、他の全ての

装置に示すための１つまたは複数のフレームを生成することと
をさらに備える、請求項４７に記載の方法。
【請求項５３】
前記複数の装置のうちの１つまたは複数から、少なくとも１つのシングルユーザ（ＳＵ）フレームを取得することと、
前記ＳＵフレームに応答して、ＳＵ送信機会（ＴＸＯＰ）許可、ＭＵ ＴＸＯＰ許可、または肯定応答（ＡＣＫ）フレームを生成することと
をさらに備える、請求項４７に記載の方法。
【請求項５４】
前記第１のフレーム内に、前記複数の装置による前記媒体へのコンテンションベースのアクセスのための１つまたは複数のバックオフパラメータを含めることをさらに備える、請求項４７に記載の方法。
【請求項５５】
前記複数の装置のうちの１つまたは複数からフレームを取得することと、
前記取得されたフレームの受信に基づいてバックオフカウントダウンタイマを開始することと、前記バックオフカウントダウンタイマに基づいて前記第１のフレームの送信を遅らせる
をさらに備える、請求項４７に記載の方法。
【請求項５６】
前記複数の装置のうちの１つまたは複数に関連付けられた残りのバックオフ時間を示す、前記複数の装置のうちの前記１つまたは複数からのフレームを取得することと、
前記残りのバックオフ時間に基づいて前記第１のフレームを用いてどの装置をターゲットとするかを決定することと
をさらに備える、請求項４７に記載の方法。
【請求項５７】
ワイヤレス通信のための装置であって、
前記装置がマルチユーザ（ＭＵ）通信を介してアクセスポイント（ＡＰ）と通信するように構成される間、前記ＡＰへの送信のためにシングルユーザ（ＳＵ）フレームを生成するための手段と、
送信のために前記ＳＵフレームを出力するための手段と
を備える、装置。
【請求項５８】
拡張分散チャネルアクセス（ＥＤＣＡ）パラメータの第１のセットに従って、前記ＳＵフレームの送信のために、媒体へのアクセスを求めて競合するための手段をさらに備える、請求項５７に記載の装置。
【請求項５９】
ＥＤＣＡパラメータの前記第１のセットは、前記装置がＭＵ通信を介して前記ＡＰと通信するように構成されないときに前記媒体へのアクセスを求めて競合するために使用されるＥＤＣＡパラメータの第２のセットとは異なる、請求項５８に記載の装置。
【請求項６０】
前記ＡＰからＥＤＣＡパラメータの前記第１および第２のセットを取得するための手段をさらに備える、請求項５８に記載の装置。
【請求項６１】
ＭＵ通信に関連した１つまたは複数の条件を検出することに応答して、ＥＤＣＡパラメータの前記第１のセットを調整するための手段
をさらに備える、請求項５９に記載の装置。
【請求項６２】
調整するための前記手段は、
前記装置がＭＵ通信を介して前記ＡＰと通信するように構成されないときに前記媒体へのアクセスを求めて競合するために使用されるＥＤＣＡパラメータの第２のセットと同じ

になるようにＥＤＣＡパラメータの前記第１のセットを設定するための手段
を備える、請求項６１に記載の装置。
【請求項６３】
前記ＳＵフレームは、データフレーム、送信機会（ＴＸＯＰ）要求を有するデータフレーム、待ち行列ステータス情報を有するフレーム、またはＴＸＯＰ要求を示す制御フレームを備える、
請求項５７に記載の装置。
【請求項６４】
前記ＳＵフレームの前記送信の後に、ＳＵ ＴＸＯＰ許可、ＭＵ ＴＸＯＰ許可、または肯定応答（ＡＣＫ）フレームを取得するための手段をさらに備える、請求項５７に記載の装置。
【請求項６５】
前記ＡＣＫフレームは、前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするために前記ＡＰから送られるフレームの送信のタイミングのインジケーションを備える、請求項６４に記載の装置。
【請求項６６】
前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするように構成されたトリガフレームを、前記ＡＰから取得するための手段をさらに備える、請求項５７に記載の装置。
【請求項６７】
前記トリガフレームは、前記装置および前記１つまたは複数の装置のために、媒体へのコンテンションベースのアクセスのための１つまたは複数のバックオフパラメータを示す
、
請求項６６に記載の装置。
【請求項６８】
前記トリガフレームを取得することまたは前記トリガフレームによってトリガされたＭＵ送信の成功には関係なく、バックオフカウントダウンタイマを開始し、前記バックオフカウントダウンタイマを維持するための手段をさらに備える、請求項６６に記載の装置。
【請求項６９】
前記トリガフレームによってトリガされたＭＵ送信の成功または失敗に少なくとも部分的に基づいて、バックオフカウントダウンを調整するための手段をさらに備える、請求項６６に記載の装置。
【請求項７０】
前記トリガフレームによってトリガされたＭＵ送信が成功する場合、ＳＵ送信のために前記媒体にアクセスするためのコンテンションウィンドウを増加させるための手段をさらに備える、請求項６６に記載の装置。
【請求項７１】
前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整するための手段
をさらに備え、前記調整は、前記装置においてバッファされたデータの量に基づく、請求項５７に記載の装置。
【請求項７２】
前記装置においてバッファされたデータの前記量が閾値に等しいかまたは閾値を超える場合、コンテンションウィンドウサイズを調整するための手段をさらに備える、請求項７１に記載の装置。
【請求項７３】
前記装置および１つまたは複数の他の装置からのＭＵ送信をトリガするように構成された１つまたは複数のトリガフレームを、前記ＡＰから取得するための手段と、
前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整するための手段と、

をさらに備え、前記調整は、前記ＡＰから受信した前記１つまたは複数のトリガフレームの周波数に基づく、請求項５７に記載の装置。
【請求項７４】
前記ＳＵフレームの送信のために媒体へのアクセスを求める競合中に、１つまたは複数のバックオフパラメータを調整するための手段をさらに備え、前記調整は、前記ＳＵフレームの長さに基づく、
請求項５７に記載の装置。
【請求項７５】
ワイヤレス通信のための装置であって、
複数の装置からのマルチユーザ（ＭＵ）送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するための手段と、
送信のために前記第１のフレームを出力するための手段と
を備える、装置。
【請求項７６】
前記複数の装置からのＭＵ送信をトリガするために、第２のフレームを周期的に生成するための手段をさらに備える、請求項７５に記載の装置。
【請求項７７】
前記複数の装置のうちの１つまたは複数がバッファされたデータを有するとのインジケーションを有する１つまたは複数のフレームを取得するための手段と、
前記インジケーションに応答して、前記第１のフレームを生成するための手段と
をさらに備える、請求項７５に記載の装置。
【請求項７８】
前記１つまたは複数の取得されたフレームは、シングルユーザ（ＳＵ）フレームを備える、請求項７７に記載の装置。
【請求項７９】
前記ＳＵフレームは、データフレーム、送信機会（ＴＸＯＰ）要求を有するデータフレーム、待ち行列ステータス情報を有するフレーム、またはＴＸＯＰ要求を示す制御フレームのうちの少なくとも１つを備える、
請求項７８に記載の装置。
【請求項８０】
前記複数の装置のうちの１つまたは複数から、少なくとも１つのシングルユーザ（ＳＵ）フレームを取得するための手段と、
前記少なくとも１つのＳＵフレームを送るために前記媒体にアクセスするのに使用するための拡張分散チャネルアクセス（ＥＤＣＡ）パラメータの第１のセットを、他の全ての装置に示すための１つまたは複数のフレームを生成するための手段と
をさらに備える、請求項７５に記載の装置。
【請求項８１】
前記複数の装置のうちの１つまたは複数から、少なくとも１つのシングルユーザ（ＳＵ）フレームを取得するための手段と、
前記ＳＵフレームに応答して、ＳＵ送信機会（ＴＸＯＰ）許可、ＭＵ　ＴＸＯＰ許可、または肯定応答（ＡＣＫ）フレームを生成するための手段と
をさらに備える、請求項７５に記載の装置。
【請求項８２】
前記第１のフレーム内に、前記複数の装置による前記媒体へのコンテンションベースのアクセスのための１つまたは複数のバックオフパラメータを含めるための手段をさらに備える、請求項７５に記載の装置。
【請求項８３】
前記複数の装置のうちの１つまたは複数からフレームを取得するための手段と、
前記取得されたフレームの受信に基づいてバックオフカウントダウンタイマを開始し、前記バックオフカウントダウンタイマに基づいて前記第１のフレームの送信を遅らせるた

めの手段と
をさらに備える、請求項７５に記載の装置。
【請求項８４】
前記複数の装置のうちの１つまたは複数に関連付けられた残りのバックオフ時間を示す、前記複数の装置のうちの前記１つまたは複数からのフレームを取得するための手段と、
前記残りのバックオフ時間に基づいて前記第１のフレームを用いてどの装置をターゲットとするかを決定するための手段と
をさらに備える、請求項７５に記載の装置。
【請求項８５】
装置がマルチユーザ（ＭＵ）通信を介してアクセスポイント（ＡＰ）と通信するように構成される間、前記ＡＰへの送信のためにシングルユーザ（ＳＵ）フレームを生成することと、
送信のために前記ＳＵフレームを出力することと
を行うための命令を記憶する、コンピュータ可読媒体。
【請求項８６】
複数の装置からのマルチユーザ（ＭＵ）送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合することと、
送信のために前記第１のフレームを出力することと
を行うための命令を記憶する、コンピュータ可読媒体。
【請求項８７】
局であって、
少なくとも１つのアンテナと、
前記局がマルチユーザ（ＭＵ）通信を介してアクセスポイント（ＡＰ）と通信するように構成される間、前記ＡＰへの送信のためにシングルユーザ（ＳＵ）フレームを生成するように構成された処理システムと、
前記少なくとも１つのアンテナを介して前記ＳＵフレームを送信するように構成された送信機と
を備える、局。
【請求項８８】
アクセスポイント（ＡＰ）であって、
少なくとも１つのアンテナと、
複数の装置からのマルチユーザ（ＭＵ）送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するように構成された処理システムと、
前記少なくとも１つのアンテナを介して前記第１のフレームを送信するように構成された送信機と
を備える、アクセスポイント。
【発明の詳細な説明】
【米国特許法第１１９条に基づく優先権の主張】
【０００１】
[0001] 本願は、本明細書の譲受人に譲渡され、本明細書内に参照により明示的に組み込まれた、２０１５年１月７日に出願された米国仮特許出願第６２／１００，８５９号（代理人整理番号１５１４２１ＵＳＬ）の利益を主張する、２０１６年１月６日に出願された米国特許出願第１４／９８９，３０２号の優先権を主張する。
【技術分野】
【０００２】
[0002] 本開示のある特定の態様は、一般に、ワイヤレス通信に関し、より具体的には、アップリンク（ＵＬ）複数ユーザ（ＭＵ：multiple user）プロトコルにおけるワイヤレスデバイスの競合（contention）およびバックオフ挙動（backoff behavior）に関する。

【背景技術】
【０００３】
[0003] ワイヤレス通信ネットワークは、音声、ビデオ、パケットデータ、メッセージング、ブロードキャストなどのような、様々な通信サービスを提供するために広く展開されている。これらのワイヤレスネットワークは、利用可能なネットワークリソースを共有することによって複数ユーザをサポートすることが可能な多元接続ネットワークであり得る。このような多元接続ネットワークの例は、符号分割多元接続（ＣＤＭＡ）ネットワーク、時分割多元接続（ＴＤＭＡ）ネットワーク、周波数分割多元接続（ＦＤＭＡ）ネットワーク、直交ＦＤＭＡ（ＯＦＤＭＡ）ネットワーク、およびシングルキャリアＦＤＭＡ（ＳＣ－ＦＤＭＡ）ネットワークを含む。
【０００４】
[0004] ワイヤレス通信システムに対して求められる、増大する帯域幅要求の課題に対処するために、高データスループットを取得しながらチャネルリソースを共有することによって、複数のユーザ端末が単一のアクセスポイントと通信することを可能にするための異なるスキームが開発されている。多入力多出力（ＭＩＭＯ）技術は、通信システムのためのポピュラーな技法として現れた、このようなアプローチを代表するものである。ＭＩＭＯ技術は、米国電気電子学会（ＩＥＥＥ）８０２．１１規格のようないくつかのワイヤレス通信規格に採用されている。ＩＥＥＥ８０２．１１は、ＩＥＥＥ８０２．１１委員会によって短距離通信（例えば、数十メートルから数百メートル）のために開発された、ワイヤレスローカルエリアネットワーク（ＷＬＡＮ）のエアインターフェース規格のセットを示す。
【発明の概要】
【０００５】
[0005] 本開示のシステム、方法、およびデバイスは各々、いくつかの態様を有し、これらのうちのいずれも、その望ましい属性を単独で担うものではない。下記の請求項によって示される本開示の範囲を限定することなく、いくつかの特徴が簡潔に説明されるだろう。本論述を考慮した後、特に「詳細な説明」と題されたセクションを読んだ後、当業者は、ワイヤレスネットワーク内の改善された通信を含む利点を本開示の特徴がどのように提供するかを理解するであろう。
【０００６】
[0006] 本開示の態様は、一般に、アップリンク（ＵＬ）複数ユーザ（ＭＵ）プロトコルにおけるアクセスポイント（ＡＰ）および局（ＳＴＡ）の競合およびバックオフ挙動に関する。
【０００７】
[0007] 本開示のある特定の態様は、ワイヤレス通信のための装置を提供する。装置は、一般に、装置がＭＵ通信を介してＡＰと通信するように構成される間、ＡＰへの送信のためにシングルユーザ（ＳＵ）フレームを生成するように構成された処理システムと、送信のためにＳＵフレームを出力するように構成された送信インターフェースとを含む。
【０００８】
[0008] 本開示のある特定の態様は、ワイヤレス通信のための装置を提供する。装置は、一般に、複数の装置からのＭＵ送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するように構成された処理システムと、送信のために第１のフレームを出力するように構成された送信インターフェースとを含む。
【０００９】
[0009] 本開示のある特定の態様は、ワイヤレス通信のための方法を提供する。方法は、一般に、装置がＭＵ通信を介してＡＰと通信するように構成される間、ＡＰへの送信のためにＳＵフレームを生成することと、送信のためにＳＵフレームを出力することとを含む。
【００１０】
[0010] 本開示のある特定の態様は、ワイヤレス通信のための方法を提供する。方法は

、一般に、複数の装置からのＭＵ送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合することと、送信のために第１のフレームを出力することとを含む。

【００１１】

[0011] 本開示のある特定の態様は、ワイヤレス通信のための装置を提供する。装置は、一般に、装置がＭＵ通信を介してＡＰと通信するように構成される間、ＡＰへの送信のためにＳＵフレームを生成するための手段と、送信のためにＳＵフレームを出力するための手段とを含む。

【００１２】

[0012] 本開示のある特定の態様は、ワイヤレス通信のための装置を提供する。装置は、一般に、複数の装置からのＭＵ送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するための手段と、送信のために第１のフレームを出力するための手段とを含む。

【００１３】

[0013] 本開示のある特定の態様は、装置がＭＵ通信を介してＡＰと通信するように構成される間、ＡＰへの送信のためにＳＵフレームを生成することと、送信のためにＳＵフレームを出力することとを行うための命令を記憶するコンピュータ可読媒体を提供する。

【００１４】

[0014] 本開示のある特定の態様は、コンピュータプログラム製品を提供する。コンピュータプログラム製品は、一般に、ＭＵ送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するための命令を記憶するコンピュータ可読媒体を含む。

【００１５】

[0015] 本開示のある特定の態様は、局を提供する。局は、一般に、少なくとも１つのアンテナと、局がＭＵ通信を介してＡＰと通信するように構成される間、ＡＰへの送信のためにＳＵフレームを生成するように構成された処理システムと、少なくとも１つのアンテナを介してＳＵフレームを送信するように構成された送信機とを含み得る。

【００１６】

[0016] 本開示のある特定の態様は、ＡＰを提供する。ＡＰは、一般に、少なくとも１つのアンテナと、複数の装置からのＭＵ送信をトリガするために、第１のフレームを生成することによって媒体へのアクセスを求めて競合するように構成された処理システムと、少なくとも１つのアンテナを介して第１のフレームを送信するように構成された送信機とを含み得る。

【００１７】

[0017] 上記のおよび関連する目的の達成のために、１つまたは複数の態様は、下記で十分に説明されかつ特許請求の範囲において特に指摘される特徴を備えている。下記の説明および添付された図面は、１つまたは複数の態様のある特定の例示的な特徴を詳細に記載する。しかしながら、これらの特徴は、様々な態様の原理が用いられ得る様々な方法のうちのほんの数例を示すものであり、本説明は、全てのこのような態様およびそれらの均等物を含むことが意図される。

【図面の簡単な説明】

【００１８】

【図１】[0018] 図１は、本開示のある特定の態様に従った、ワイヤレス通信ネットワークの例を図示する。

【図２】[0019] 図２は、本開示のある特定の態様に従った、アクセスポイント（ＡＰ）およびユーザ端末の例のブロック図である。

【図３】[0020] 図３は、本開示のある特定の態様に従った、ワイヤレスデバイスの例のブロック図である。

【図４】[0021] 図４は、本開示のある特定の態様に従った、複数ユーザ（ＭＵ）通信のためのアップリンク（ＵＬ）ダウンリンク（ＤＬ）フレーム交換の例を図示する。

【図５】[0022] 図５は、本開示のある特定の態様に従った、ワイヤレス通信のための動作の例のフロー図である。
【図５Ａ】[0023] 図５Ａは、図５に示される動作を行うことが可能な手段の例を図示する。
【図６】[0024] 図６は、本開示のある特定の態様に従った、ＵＬ／ＤＬフレーム交換を図示する図の例である。
【図７】[0025] 図７は、本開示のある特定の態様に従った、ワイヤレス通信のための動作の例のフロー図である。
【図７Ａ】[0026] 図７Ａは、図７に示される動作を行うことが可能な手段の例を図示する。

【００１９】
[0027] 理解を容易にするため、可能な場合、図面に共通している同一の要素を明確にするために同一の参照番号が使用されている。１つの実施形態で開示される要素は、具体的な説明がなくとも、他の実施形態において効果的に利用され得ることが予期される。

【詳細な説明】

【００２０】
[0028] 本開示の様々な態様が、添付の図面に関して下記により十分に説明される。しかしながら、本開示は、多くの異なる形態で具現化され得、本開示全体を通じて表される任意の具体的な構成または機能に限定されるものと解釈されるべきではない。むしろ、本開示が綿密かつ完全なものとなり、また本開示の範囲を当業者に十分に伝えることができるように、これらの態様が提供される。本明細書における教示に基づいて、当業者は、本開示の範囲が、独立して実施されようと本開示の任意の他の態様と組み合わされて実施されようと、本明細書で説明される開示の任意の態様をカバーすることを意図していることを理解するべきである。例えば、本明細書に記載される任意の数の態様を使用して、装置が実装され得るか、または方法が実現され得る。加えて、開示の範囲は、本明細書に記載される開示の様々な態様に加えてまたはそれ以外の、他の構成、機能、または構成および機能を使用して実現される、このような装置または方法をカバーすることを意図している。本明細書で開示される開示の任意の態様は、請求項の１つまたは複数の要素によって具現化され得ることが理解されるべきである。

【００２１】
[0029] 本開示の態様は、一般に、アップリンク（ＵＬ）複数ユーザ（ＭＵ）プロトコルにおけるアクセスポイント（ＡＰ）および局（ＳＴＡ）の競合およびバックオフ挙動に関する。本明細書でより詳細に説明されるように、ＭＵ動作に従事するＳＴＡは、要請されていない（unsolicited）シングルユーザ（ＳＵ）送信を送ることが可能であり得る。ＡＰは、ＭＵトリガフレームを送るために、媒体へのアクセスを求めて競合し得る。ある特定の態様に従って、ＡＰは、例えば、ＳＵおよびＭＵ送信のための拡張分散チャネルアクセス（ＥＤＣＡ）パラメータを制御することによって、ＭＵ送信を優遇して（in favor of）、ＳＵ送信の優先度を下げ（deprioritize）得る。

【００２２】
[0030] 「例示的な」という用語は、本明細書では「例、実例、または例示としての役割を果たす」という意味で使用される。「例示的」であるとして本明細書で説明される任意の態様が、必ずしも他の態様よりも好ましいまたは有利であると解釈されるべきでない。

【００２３】
[0031] 特定の態様が本明細書に説明されるが、これらの態様の多くのバリエーションおよび並び替えが、本開示の範囲内に含まれる。好ましい態様のいくつかの利益および利点が述べられるが、本開示の範囲は、特定の利益、使用、または目的に限定されることを意図しない。むしろ、本開示の態様は、異なるワイヤレス技術、システム構成、ネットワーク、および送信プロトコルに広く適用可能であることを意図しており、そのいくつかは、図面および好ましい態様の下記の説明において例として図示される。詳細な説明および

図面は、限定するよりもむしろ単に本開示を例示するものであり、本開示の範囲は、添付の請求項およびそれらの均等物によって定義されている。

【００２４】

[0032] 本明細書で説明される技法は、直交多重化方式に基づく通信システムを含む、様々なブロードバンドワイヤレス通信システムのために使用され得る。このような通信システムの例は、空間分割多元接続（ＳＤＭＡ）システム、時分割多元接続（ＴＤＭＡ）システム、直交周波数分割多元接続（ＯＦＤＭＡ）システム、およびシングルキャリア周波数分割多元接続（ＳＣ－ＦＤＭＡ）システムを含む。ＳＤＭＡシステムは、複数のユーザ端末に属するデータを同時に送信するために、十分に異なる方向を利用し得る。ＴＤＭＡシステムは、送信信号を異なるタイムスロットに分割することによって、複数のユーザ端末が同じ周波数チャネルを共有することを可能にし得、各タイムスロットは、異なるユーザ端末に割り当てられる。ＯＦＤＭＡシステムは、システム帯域幅全体を複数の直交サブキャリアに分割する変調技法である、直交周波数分割多重（ＯＦＤＭ）を利用する。これらのサブキャリアは、トーン、ビンなどとも呼ばれ得る。ＯＦＤＭでは、各サブキャリアは、データと共に独立して変調され得る。ＳＣ－ＦＤＭＡシステムは、システム帯域幅にわたって分散されたサブキャリア上で送信するためにインターリーブされたＦＤＭＡ（ＩＦＤＭＡ）を、隣接するサブキャリアのブロック上で送信するためにローカライズされたＦＤＭＡ（ＬＦＤＭＡ）を、または隣接するサブキャリアの複数のブロック上で送信するために拡張されたＦＤＭＡ（ＥＦＤＭＡ）を利用し得る。一般に、変調シンボルは、ＯＦＤＭを用いて周波数領域で、ＳＣ－ＦＤＭＡを用いて時間領域で送られる。

【００２５】

[0033] 本明細書における教示は、様々なワイヤードまたはワイヤレス装置（例えば、ノード）に組み込まれ得る（例えば、それらの中に実装されるか、またはそれらによって行われる）。いくつかの態様では、本明細書における教示に従って実装されるワイヤレスノードは、アクセスポイントまたはアクセス端末を備え得る。

【００２６】

[0034] アクセスポイント（「ＡＰ」）は、ノードＢ、無線ネットワークコントローラ（「ＲＮＣ」）、発展型ノードＢ（ｅＮＢ）、基地局コントローラ（「ＢＳＣ」）、基地トランシーバ局（「ＢＴＳ」）、基地局（「ＢＳ」）、トランシーバ機能（「ＴＦ」）、無線ルータ、無線トランシーバ、ベーシックサービスセット（「ＢＳＳ」）、拡張サービスセット（「ＥＳＳ」）、無線基地局（「ＲＢＳ」）、または何らかの他の専門用語として知られ、実装され、またはそれらを備え得る。

【００２７】

[0035] アクセス端末（「ＡＴ」）は、加入者局、加入者ユニット、モバイル局（ＭＳ）、遠隔局、遠隔端末、ユーザ端末（ＵＴ）、ユーザエージェント、ユーザデバイス、ユーザ機器（ＵＥ）、ユーザ局、または何らかの他の専門用語として知られ、実装され、またはそれらを備え得る。いくつかの実装では、アクセス端末は、セルラ電話、コードレス電話、セッション開始プロトコル（「ＳＩＰ」）電話、ワイヤレスローカルループ（「ＷＬＬ」）局、携帯情報端末（「ＰＤＡ」）、ワイヤレス接続能力を有するハンドヘルドデバイス、局（「ＳＴＡ」）、またはワイヤレスモデムに接続された何らかの他の適切な処理デバイスを備え得る。従って、本明細書で教示される１つまたは複数の態様は、電話（例えば、セルラフォンまたはスマートフォン）、コンピュータ（例えば、ラップトップ）、タブレット、ポータブル通信デバイス、ポータブルコンピューティングデバイス（例えば、携帯情報端末）、エンターテインメントデバイス（例えば、音楽または映像デバイス、あるいは衛星ラジオ）、全地球測位システム（ＧＰＳ）デバイス、あるいはワイヤレスまたはワイヤード媒体を介して通信するように構成された任意の他の適切なデバイスに組み込まれ得る。いくつかの態様では、ＡＴは、ワイヤレスノードであり得る。このようなワイヤレスノードは、例えば、ワイヤードまたはワイヤレス通信リンクを介するネットワーク（例えば、インターネットまたはセルラネットワークのような広域ネットワーク）のための、またはネットワークへの接続を提供し得る。

【００２８】
［ワイヤレス通信システムの例］
[0036] 図１は、本開示の態様が行われ得るシステム１００を図示する。例えば、ユーザ端末（一般に、局またはＳＴＡとも呼ばれ得る）１２０は、マルチユーザ（ＭＵ：multi-user）送信を介してアクセスポイント１１０と通信するように構成され得る。ユーザ端末１２０はまた、アクセスポイント１１０への送信のために、要請されていないシングルユーザ（ＳＵ）フレームを生成することを可能にし得る。アクセスポイント１１０はまた、ユーザ端末１２０にＭＵトリガフレームを送るために、媒体へのアクセスを求めて競合し得る。
【００２９】
[0037] システム１００は、例えば、アクセスポイントおよびユーザ端末を用いた多元接続他入力多出力（ＭＩＭＯ）システム１００であり得る。簡潔化のために、１つのアクセスポイント１１０のみが図１に示されている。アクセスポイントは通常、ユーザ端末と通信する固定局であり、基地局または何らかの他の専門用語でも呼ばれ得る。ユーザ端末は、固定またはモバイルであり得、モバイル局、ワイヤレスデバイス、または何らかの他の専門用語でも呼ばれ得る。アクセスポイント１１０は、ダウンリンクおよびアップリンク上で、任意の所与の瞬間に１つまたは複数のユーザ端末１２０と通信し得る。ダウンリンク（すなわち、順方向リンク）は、アクセスポイントからユーザ端末への通信リンクであり、アップリンク（すなわち、逆方向リンク）は、ユーザ端末からアクセスポイントへの通信リンクである。ユーザ端末はまた、別のユーザ端末とピア・ツー・ピアで通信し得る。
【００３０】
[0038] システムコントローラ１３０は、これらのＡＰおよび／または他のシステムに対して協調および制御を提供し得る。ＡＰは、例えば、無線周波数電力、チャネル、認証、およびセキュリティのための調整を行い得るシステムコントローラ１３０によって管理され得る。システムコントローラ１３０は、バックホールを介してＡＰと通信し得る。ＡＰはまた、例えば、ワイヤレスまたはワイヤーラインバックホールを介して間接的にあるいは直接的に互いに通信し得る。
【００３１】
[0039] 下記の開示の一部は、空間分割多元接続（ＳＤＭＡ）を介する通信が可能なユーザ端末１２０を説明する一方、ある特定の態様では、ユーザ端末１２０はまた、ＳＤＭＡをサポートしないいくつかのユーザ端末を含み得る。よって、このような態様では、ＡＰ １１０は、ＳＤＭＡユーザ端末と非ＳＤＭＡユーザ端末の両方と通信するように構成され得る。このアプローチは、より新しいＳＤＭＡユーザ端末が適切とみなされるときに導入されることを可能にしながら、より古いバージョンのユーザ端末（「レガシ」局）が事業展開され続けることを都合良く可能にし得、それらの耐用年数を引き延ばす。
【００３２】
[0040] システム１００は、ダウンリンクおよびアップリンク上のデータ送信のために複数の送信アンテナおよび複数の受信アンテナを用いる。アクセスポイント１１０は、N_{ap}個のアンテナを装備し、ダウンリンク送信のための多入力（ＭＩ）と、アップリンク送信のための多出力（ＭＯ）とを表す。選択されたＫ個のユーザ端末１２０のセットは、集合的に、ダウンリンク送信のための多出力と、アップリンク送信のための多入力とを表す。純粋なＳＤＭＡでは、Ｋ個のユーザ端末のためのデータシンボルストリームが、何らかの手段によって、コード、周波数、または時間で多重化されていない場合、$N_{ap} \geqq K \geqq 1$を有することが望ましい。ＴＤＭＡ技法、ＣＤＭＡを用いた異なるコードチャネル、ＯＦＤＭを用いた互いに素なサブバンドのセットなどを使用して、データシンボルストリームが多重化されることができる場合、Ｋは、N_{ap}よりも大きくなり得る。各選択されたユーザ端末は、アクセスポイントにユーザ固有のデータを送信し、および／またはアクセスポイントからユーザ固有のデータを受信する。一般に、各選択されたユーザ端末は、１つまたは複数（すなわち、$N_{ut} \geqq 1$）のアンテナを装備し得る。Ｋ個の選択されたユ

ーザ端末は、同じまたは異なる数のアンテナを有し得る。

【００３３】

[0041] システム１００は、時分割複信（ＴＤＤ）システムまたは周波数分割複信（ＦＤＤ）システムであり得る。ＴＤＤシステムでは、ダウンリンクとアップリンクは、同じ周波数帯域を共有する。ＦＤＤシステムでは、ダウンリンクとアップリンクは、異なる周波数帯域を使用する。ＭＩＭＯシステム１００はまた、送信のために単一キャリアまたは複数キャリアを利用し得る。各ユーザ端末は、（例えば、コストを低く抑えるために）単一のアンテナを、または（例えば、追加のコストがサポートされ得る場合には）複数のアンテナを装備し得る。ユーザ端末１２０が異なるタイムスロットに送信／受信を分割することによって同じ周波数チャネルを共有する場合、システム１００はまた、ＴＤＭＡシステムでもあり得、各タイムスロットは、異なるユーザ端末１２０に割り当てられる。

【００３４】

[0042] 図２は、図１に図示されるＡＰ １１０およびＵＴ １２０のコンポーネントの例を図示し、これらは、本開示の態様を実施するために使用され得る。ＡＰ １１０およびＵＴ １２０の１つまたは複数のコンポーネントは、本開示の態様を実現するように使用され得る。例えば、アクセスポイント１１０のアンテナ２２４、Ｔｘ／Ｒｘ２２２、プロセッサ２１０、２２０、２４０、２４２、および／またはコントローラ２３０は、本明細書で説明され、図７および７Ａに関して図示される動作を行うために使用され得る。同様に、ユーザ端末１２０のアンテナ２５２、Ｔｘ／Ｒｘ２５４、プロセッサ２６０、２７０、２８８、２９０、および／またはコントローラ２８０は、本明細書で説明され、図５および５Ａに関して図示される動作を行うために使用され得る。

【００３５】

[0043] 図２は、ＭＩＭＯシステムにおける、アクセスポイント１１０、２つのユーザ端末１２０ｍおよび１２０ｘのブロック図を図示する。アクセスポイント１１０は、N_t個のアンテナ２２４ａ～２２４ａｐを装備している。ユーザ端末１２０ｍは、$N_{ut,m}$個のアンテナ２５２ｍａ～２５２ｍｕを装備しており、ユーザ端末１２０ｘは、$N_{ut,x}$個のアンテナ２５２ｘａ～２５２ｘｕを装備している。アクセスポイント１１０は、ダウンリンクについては送信エンティティであり、アップリンクについては受信エンティティである。各ユーザ端末１２０は、アップリンクについては送信エンティティであり、ダウンリンクについては受信エンティティである。本明細書で使用されるような「送信エンティティ」は、ワイヤレスチャネルを介してデータを送信することが可能な独立して動作する装置またはデバイスであり、「受信エンティティ」は、ワイヤレスチャネルを介してデータを受信することが可能な独立して動作する装置またはデバイスである。下記の説明では、下付きの文字「ｄｎ」はダウンリンクを示し、また下付きの文字「ｕｐ」はアップリンクを示しており、N_{up}個のユーザ端末がアップリンク上の同時送信のために選択され、N_{dn}個のユーザ端末がダウンリンク上の同時送信のために選択され、N_{up}は、N_{dn}と等しいかまたは等しくない可能性があり、N_{up}およびN_{dn}は、スケジューリング間隔ごとに静的な値であり得るか、または変化し得る。ビームステアリングまたは何らかの他の空間処理技法が、アクセスポイントおよびユーザ端末で使用され得る。

【００３６】

[0044] アップリンク上では、アップリンク送信のために選択された各ユーザ端末１２０において、送信（ＴＸ）データプロセッサ２８８は、データソース２８６からトラフィックデータを、コントローラ２８０から制御データを受信する。コントローラ２８０は、メモリ２８２と結合され得る。ＴＸデータプロセッサ２８８は、ユーザ端末のために選択されたレートに関連付けられたコーディングおよび変調スキームに基づいて、ユーザ端末のためのトラフィックデータを処理（例えば、符号化、インターリーブ、および変調）し、データシンボルストリームを提供する。ＴＸ空間プロセッサ２９０は、そのデータシンボルストリーム上で空間処理を行い、$N_{ut,m}$個のアンテナのために$N_{ut,m}$個の送信シンボルストリームを提供する。各送信機ユニット（ＴＭＴＲ）２５４は、アップリンク信号を生成するために、それぞれの送信シンボルストリームを受信および処理（例えば

、アナログへの変換、増幅、フィルタリング、周波数アップコンバート）する。$N_{ut,m}$個の送信機ユニット２５４は、$N_{ut,m}$個のアンテナ２５２からアクセスポイントに送信するための、$N_{ut,m}$個のアップリンク信号を提供する。

【００３７】

[0045] N_{up}個のユーザ端末は、アップリンク上の同時送信のためにスケジューリングされ得る。これらのユーザ端末の各々は、そのデータシンボルストリーム上で空間処理を行い、アップリンク上でその送信シンボルストリームのセットをアクセスポイントに送信する。

【００３８】

[0046] アクセスポイント１１０において、N_{ap}個のアンテナ２２４ａ～２２４ａｐは、アップリンク上で送信する全てのN_{up}個のユーザ端末からのアップリンク信号を受信する。各アンテナ２２４は、受信した信号をそれぞれの受信機ユニット（ＲＣＶＲ）２２２に提供する。各受信機ユニット２２２は、送信機ユニット２５４によって行われたものに対して相補的な処理を行い、受信シンボルストリームを提供する。ＲＸ空間プロセッサ２４０は、N_{ap}個の受信機ユニット２２２からのN_{ap}個の受信シンボルストリーム上で受信機空間処理を行い、N_{up}個の復元されたアップリンクデータシンボルストリームを提供する。受信機空間処理は、チャネル相関マトリクス反転（ＣＣＭＩ）、最小平均二乗誤差（ＭＭＳＥ）、ソフト干渉除去（ＳＩＣ）、または何らかの他の技法に従って行われる。各復元されたアップリンクデータシンボルストリームは、それぞれのユーザ端末によって送信されたデータシンボルストリームの推定である。ＲＸデータプロセッサ２４２は、そのストリームのために使用されたレートに従って、復号されたデータを取得するために、各復元されたアップリンクデータシンボルストリームを、処理（例えば、復調、デインターリーブ、および復号）する。各ユーザ端末のための復号されたデータは、記憶のためにデータシンク２４４に、および／またはさらなる処理のためにコントローラ２３０に提供され得る。コントローラ２３０は、メモリ２３２と結合され得る。

【００３９】

[0047] ダウンリンク上では、アクセスポイント１１０において、ＴＸデータプロセッサ２１０は、データソース２０８から、ダウンリンク送信のためにスケジューリングされたN_{dn}個のユーザ端末のためのトラフィックデータを、コントローラ２３０から制御データを、また場合によってはスケジューラ２３４から他のデータを受信する。様々なタイプのデータが、異なるトランスポートチャネル上で送られ得る。ＴＸデータプロセッサ２１０は、各ユーザ端末のためのトラフィックデータを、そのユーザ端末のために選択されたレートに基づいて処理（例えば、符号化、インターリーブ、および変調）する。ＴＸデータプロセッサ２１０は、N_{dn}個のユーザ端末のためにN_{dn}個のダウンリンクデータシンボルストリームを提供する。ＴＸ空間プロセッサ２２０は、N_{dn}個のダウンリンクデータシンボルストリーム上で（本開示において説明されるプリコーディングまたはビームフォーミングのような）空間処理を行い、N_{ap}個のアンテナのためにN_{ap}個の送信シンボルストリームを提供する。各送信機ユニット２２２は、ダウンリンク信号を生成するために、それぞれの送信シンボルストリームを受信および処理する。N_{ap}個の送信機ユニット２２２は、N_{ap}個のアンテナ２２４からユーザ端末への送信のためにN_{ap}個のダウンリンク信号を提供する。各ユーザ端末のための復号されたデータは、記憶のためにデータシンク２７２に、および／またはさらなる処理のためにコントローラ２８０に提供され得る。

【００４０】

[0048] 各ユーザ端末１２０において、$N_{ut,m}$個のアンテナ２５２は、アクセスポイント１１０からN_{ap}個のダウンリンク信号を受信する。各受信機ユニット２５４は、関連付けられたアンテナ２５２から受信信号を処理し、受信シンボルストリームを提供する。ＲＸ空間プロセッサ２６０は、$N_{ut,m}$個の受信機ユニット２５４からの$N_{ut,m}$個の受信シンボルストリーム上で受信機空間処理を行い、ユーザ端末のための復元されたダウンリンクデータシンボルストリームを提供する。受信機空間処理は、ＣＣＭＩ、Ｍ