US 20250261069A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2025/0261069 A1

Nayak et al.

(43) Pub. Date: Aug. 14, 2025

(54) **BLOCK ACK TRANSFER HANDLING FOR WIRELESS NETWORKS**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(72) Inventors: **Peshal Nayak**, Plano, TX (US); **Boon Loong Ng**, Plano, TX (US); **Rubayet Shafin**, Allen, TX (US); **Vishnu Vardhan Ratnam**, Frisco, TX (US); **Yue Qi**, Plano, TX (US); **Bilal Sadiq**, Plano, TX (US)

(21) Appl. No.: **19/043,306**

(22) Filed: **Jan. 31, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/551,819, filed on Feb. 9, 2024.

Publication Classification

(51) **Int. Cl.**

H04W 36/18 (2009.01)
H04L 1/1607 (2023.01)
H04W 8/02 (2009.01)

(52) **U.S. Cl.**

CPC ***H04W 36/18*** (2013.01); ***H04L 1/1621*** (2013.01); ***H04W 8/02*** (2013.01)

(57) **ABSTRACT**

A first access point (AP) in a wireless network transfers a block acknowledgment (BA) session and related parameters of a station (STA) to a second AP when the STA roams from the first AP to the second AP, allowing the STA to roam between APs without needs to terminate and re-setup up the BA session.

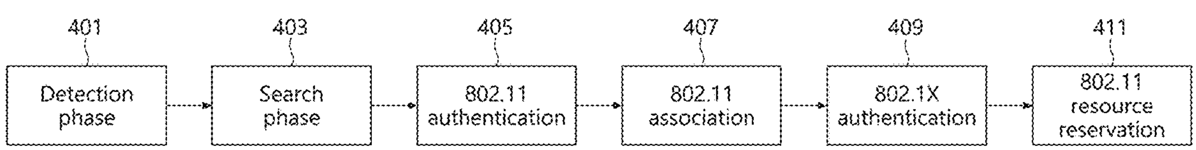


FIG. 1

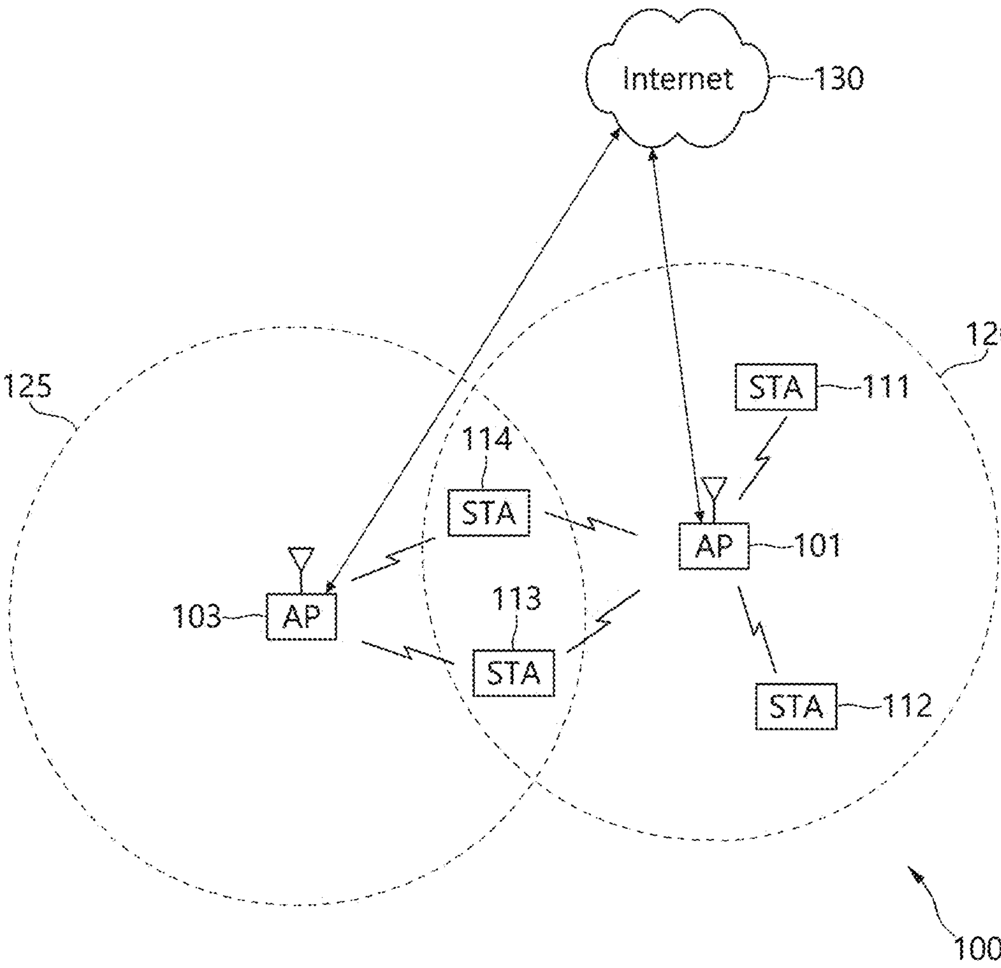

Internet
130
120
125
STA
111
114
STA
AP
101
103
AP
113
STA
STA
112
100

FIG. 2A

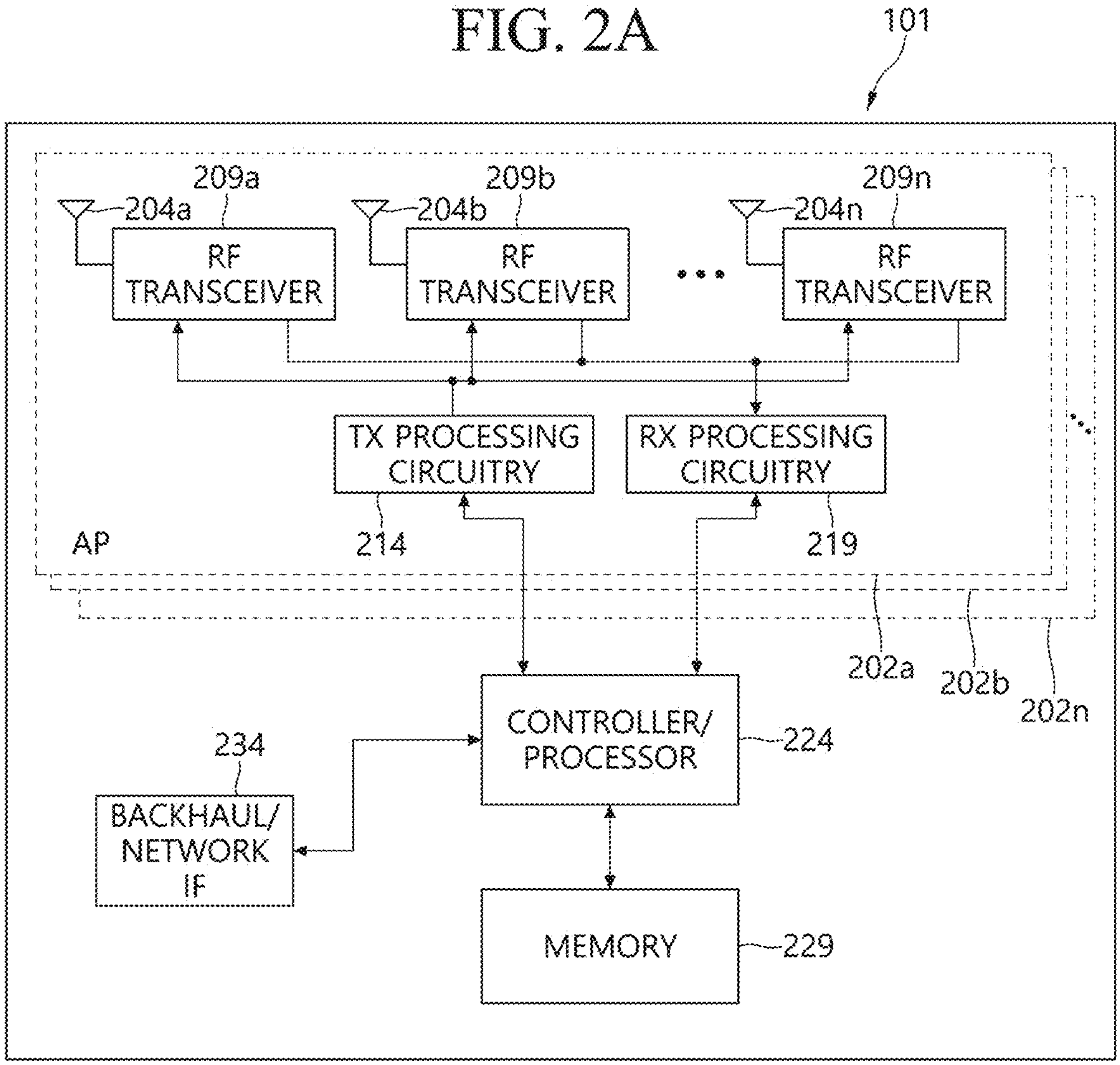

101
209a
204a
RF TRANSCEIVER
209b
204b
RF TRANSCEIVER
209n
204n
RF TRANSCEIVER
TX PROCESSING CIRCUITRY
RX PROCESSING CIRCUITRY
AP
214
219
202a
202b
202n
CONTROLLER/ PROCESSOR
224
234
BACKHAUL/ NETWORK IF
MEMORY
229

FIG. 2B

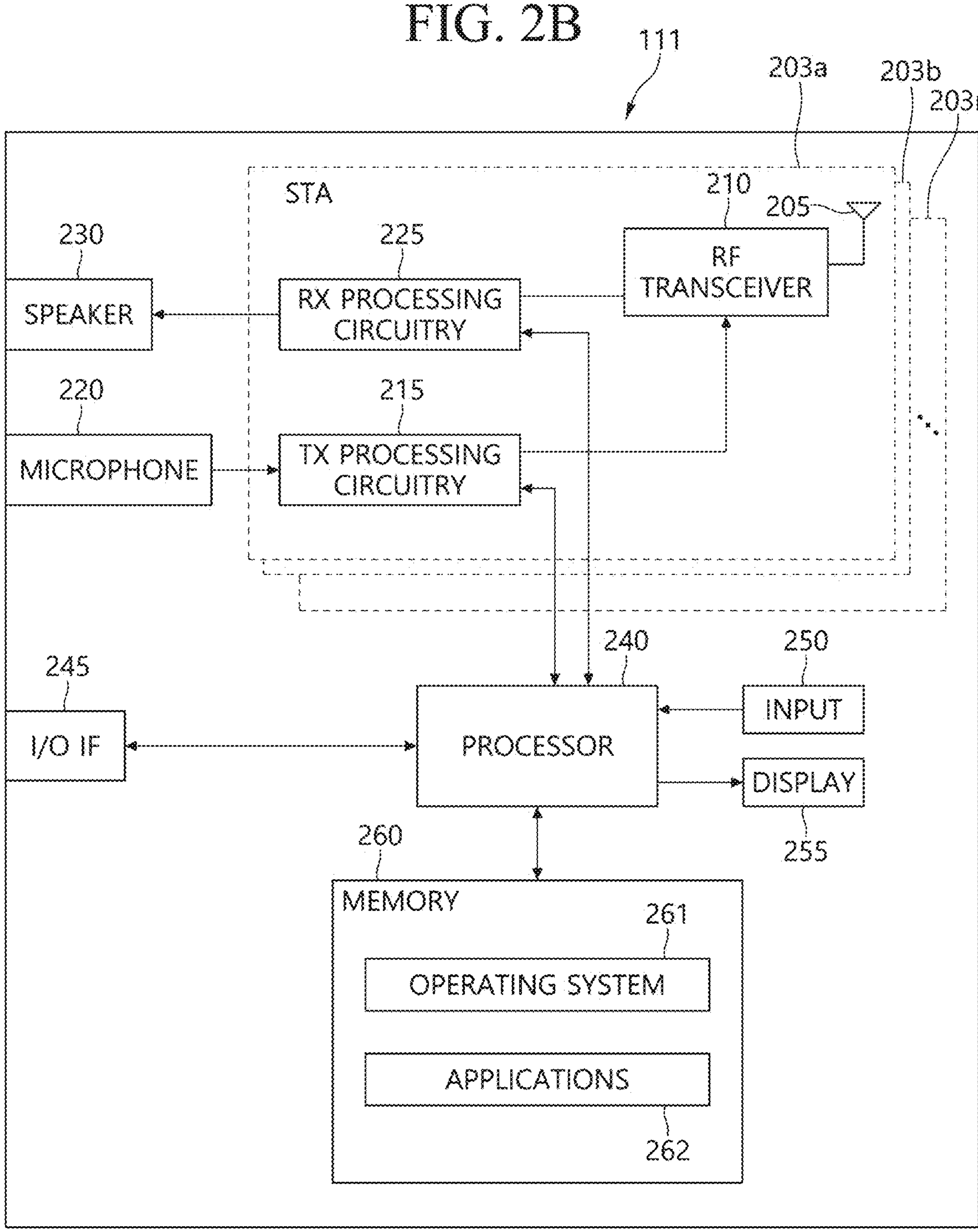

111
203a
203b
203n
STA
210
205
RF TRANSCEIVER
230
SPEAKER
225
RX PROCESSING CIRCUITRY
220
MICROPHONE
215
TX PROCESSING CIRCUITRY
245
I/O IF
240
PROCESSOR
250
INPUT
DISPLAY
255
260
MEMORY
261
OPERATING SYSTEM
APPLICATIONS
262

FIG. 3

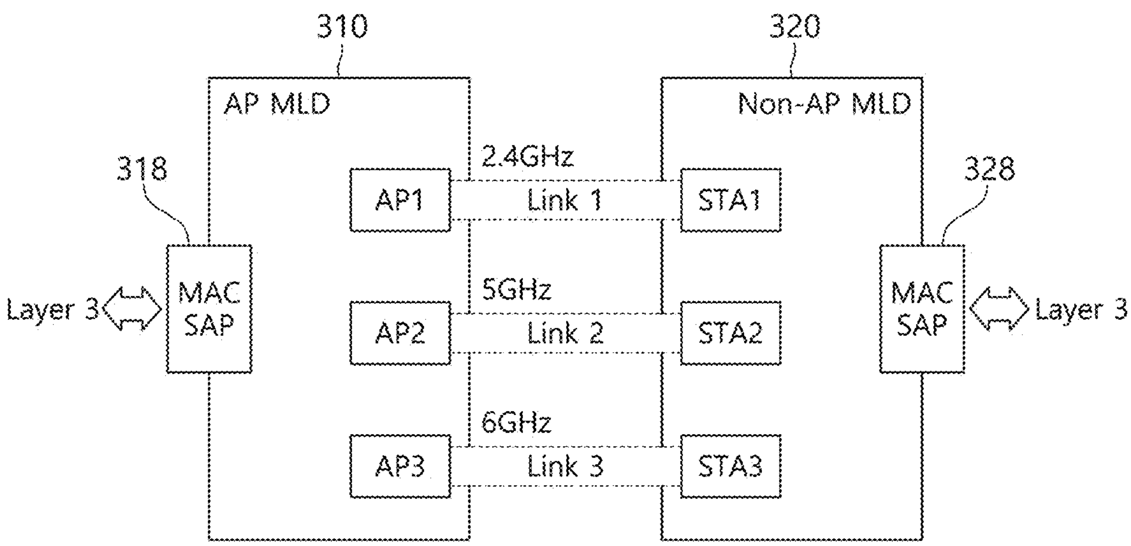

310
320
AP MLD
Non-AP MLD
318
328
2.4GHz
AP1
Link 1
STA1
MAC
SAP
Layer 3
5GHz
AP2
Link 2
STA2
MAC
SAP
Layer 3
6GHz
AP3
Link 3
STA3

FIG. 4

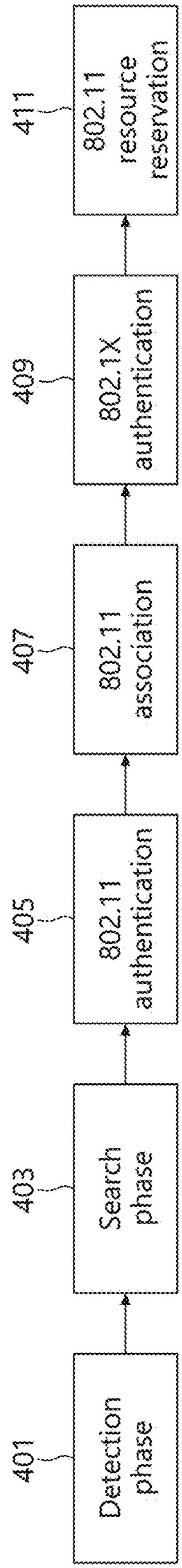

401
Detection phase
403
Search phase
405
802.11 authentication
407
802.11 association
409
802.1X authentication
411
802.11 resource reservation

FIG. 5

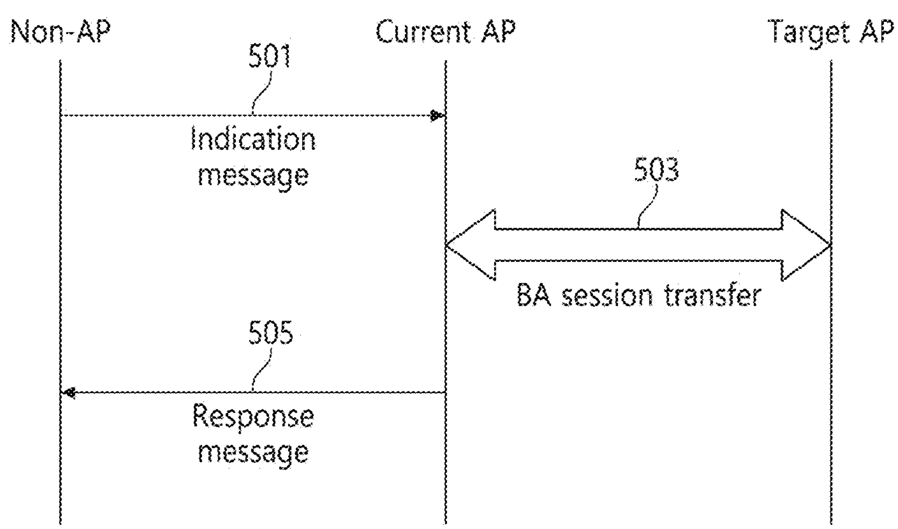

Non-AP
Current AP
Target AP
501
Indication message
503
BA session transfer
505
Response message

FIG. 6

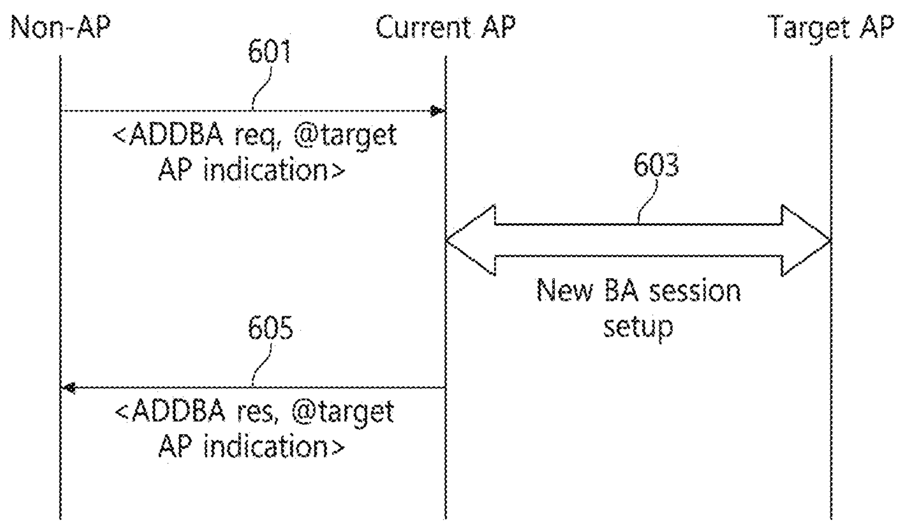

Non-AP
Current AP
Target AP
601
<ADDBA req, @target AP indication>
603
New BA session setup
605
<ADDBA res, @target AP indication>

FIG. 7

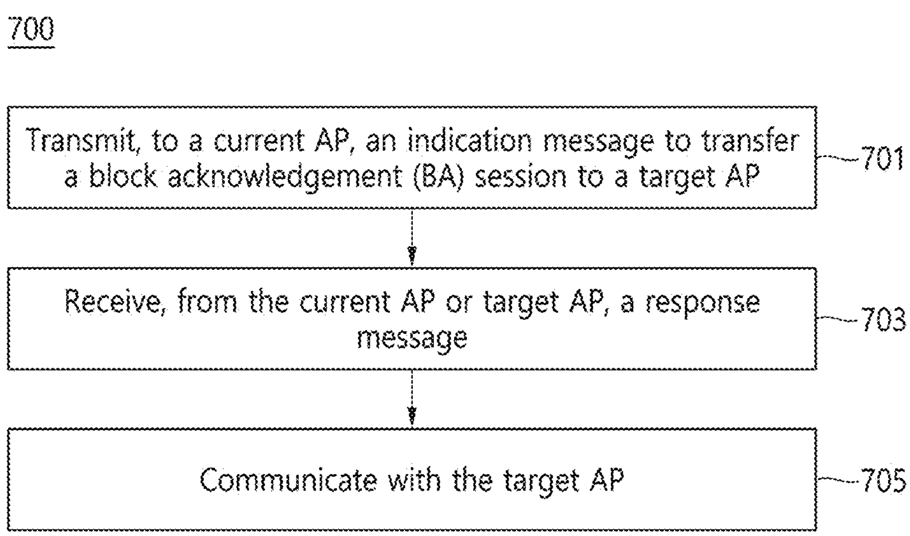
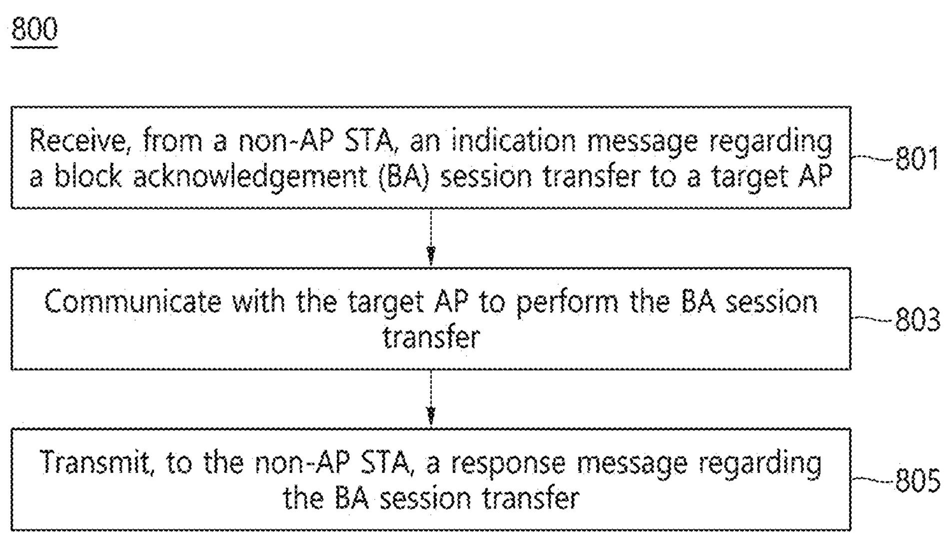

700
Transmit, to a current AP, an indication message to transfer a block acknowledgement (BA) session to a target AP
701
Receive, from the current AP or target AP, a response message
703
Communicate with the target AP
705

FIG. 8


800
Receive, from a non-AP STA, an indication message regarding a block acknowledgement (BA) session transfer to a target AP
801
Communicate with the target AP to perform the BA session transfer
803
Transmit, to the non-AP STA, a response message regarding the BA session transfer
805

BLOCK ACK TRANSFER HANDLING FOR WIRELESS NETWORKS

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of priority from U.S. Provisional Application No. 63/551,819, entitled "BLOCK ACK SETUP TRANSFER HANDLING FOR NEXT GENERATION WLANS" filed Feb. 9, 2024, all of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This disclosure relates generally to a wireless communication system, and more particularly to, for example, but not limited to, block acknowledgement setup transfer handling for wireless networks.

BACKGROUND

[0003] Wireless local area network (WLAN) technology has evolved toward increasing data rates and continues its growth in various markets such as home, enterprise and hotspots over the years since the late 1990s. WLAN allows devices to access the internet in the 2.4 GHZ, 5 GHZ, 6 GHz or 60 GHz frequency bands. WLANs are based on the Institute of Electrical and Electronic Engineers (IEEE) 802.11 standards. IEEE 802.11 family of standards aims to increase speed and reliability and to extend the operating range of wireless networks.

[0004] WLAN devices are increasingly required to support a variety of delay-sensitive applications or real-time applications such as augmented reality (AR), robotics, artificial intelligence (AI), cloud computing, and unmanned vehicles. To implement extremely low latency and extremely high throughput required by such applications, multi-link operation (MLO) has been suggested for the WLAN. The WLAN is formed within a limited area such as a home, school, apartment, or office building by WLAN devices. Each WLAN device may have one or more stations (STAs) such as the access point (AP) STA and the non-access-point (non-AP) STA.

[0005] The MLO may enable a non-AP multi-link device (MLD) to set up multiple links with an AP MLD. Each of multiple links may enable channel access and frame exchanges between the non-AP MLD and the AP MLD independently, which may reduce latency and increase throughput.

[0006] The description set forth in the background section should not be assumed to be prior art merely because it is set forth in the background section. The background section may describe aspects or embodiments of the present disclosure.

SUMMARY

[0007] One aspect of the present disclosure provides a first access point (AP) in a wireless network, comprising: a memory; and a processor coupled to the memory. The processor is configured to receive, from a station (STA), a first frame that that triggers a transfer of a block acknowledgement (BA) session to a second AP. The processor is configured to communicate with the second AP to transfer the BA session or at least one parameter associated with the BA session. The processor is configured to transmit, to the STA, a second frame in response to the first.

[0008] In some embodiments, the first frame includes at least one of an indication of an intent to roam from the first AP to the second AP, an indication of the BA session to be transferred, an indication that a sequence number or one or more parameters associated with the BA session can be reset at the second AP, or an indication of a traffic stream for which the BA session corresponds to.

[0009] In some embodiments, the second frame includes a response to the first frame and an expiration time for the BA session, wherein the BA session does not go into effect if the STA fails to roam to the second AP.

[0010] In some embodiments, the at least one parameter is: i) an information item that provides a latest sequence number to use, ii) an AP scoreboard parameter such that the second AP starts from a last state of the AP scoreboard parameter at the first AP when the second AP starts to send frames to the STA, iii) a STA scoreboard parameter such that the STA continues communication from a last state of the STA scoreboard parameter as with the first AP prior to roam, or iv) a BA session related parameter.

[0011] In some embodiments, the second frame is transmitted after the BA session is setup with the second AP.

[0012] In some embodiments, the first frame is received after roaming from the first AP to the second AP; and the processor is further configured to determine that all buffered frames are transmitted to the STA or the second AP; and terminate the BA session with the STA based on a determination that all buffered frames are transmitted to the STA or the second AP.

[0013] In some embodiments, the processor is further configured to transmit, to the STA, a third frame that indicates a capability to support the transfer of the BA session.

[0014] In some embodiments, the first AP and the second AP are affiliated with a seamless roaming domain.

[0015] One aspect of the present disclosure provides a first access point (AP) in a wireless network, comprising: a memory; and a processor coupled to the memory. The processor is configured to receive, from a station (STA), a first frame that triggers a setup of a block acknowledgement (BA) session at a second AP. The processor is configure to communicate with the second AP to setup the BA session or at least one parameter associated with the BA session. The processor is configured to transmit, to the STA, a second frame in response to the first frame.

[0016] In some embodiments, the first frame indicates that the BA session setup is for the second AP.

[0017] In some embodiments, the first frame is received prior to the STA roaming to the second AP and the first frame includes at least one of an indication of an intent to roam or a set of parameters for the BA session.

[0018] One aspect of the present disclosure provides a station (STA) in a wireless network, comprising: a memory; and a processor coupled to the memory. The processor is configured to transmit, to a first access point (AP), a first frame that triggers a transfer of a block acknowledgement (BA) session or at least one parameter associated with the BA session to a second AP. The processor is configured to receive, from the first AP or the second AP, a second frame in response to the first frame, wherein the first AP communicates with the second AP to transfer the BA session or the at least one parameter associated with the BA session.

[0019] In some embodiments, the first frame includes at least one of an indication of an intent to roam from the first

AP to the second AP, an indication of the BA session to be transferred, an indication that a sequence number or one or more parameters associated with the BA session can be reset at the second AP, or an indication of a traffic stream for which the BA session corresponds to.

[0020] In some embodiments, the second frame includes a response to the first frame and an expiration time for the BA session, wherein the BA session does not go into effect if the STA fails to roam to the second AP.

[0021] In some embodiments, the at least one parameter is: i) an information item that provides a latest sequence number to use, ii) an AP scoreboard parameter such that the second AP starts from a last state of the AP scoreboard parameter at the first AP when the second AP starts to send frames to the STA, iii) a STA scoreboard parameter such that the STA continues communication from a last state of the STA scoreboard parameter as with the first AP prior to roam, or iv) a BA session related parameter.

[0022] In some embodiments, the second frame is received after the BA session is setup with the second AP.

[0023] In some embodiments, the first frame is transmitted after roaming from the first AP to the second AP, the processor is further configured to receive, from the first AP, all buffered frames.

[0024] In some embodiments, the processor is further configured to receive, from the first AP, a third frame that indicates a capability to support the transfer of the BA session.

[0025] In some embodiments, the processor is further configured to transmit, to the second AP, a third frame that terminates the BA session.

[0026] In some embodiments, the first AP and the second AP are affiliated with a seamless roaming domain.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. **1** illustrates an example of a wireless network in accordance with an embodiment.

[0028] FIG. **2**A illustrates an example of AP in accordance with an embodiment.

[0029] FIG. **2**B illustrates an example of STA in accordance with an embodiment.

[0030] FIG. **3** illustrates an example of multi-link communication operation in accordance with an embodiment.

[0031] FIG. **4** illustrates stages of a mobility handover procedure in accordance with an embodiment.

[0032] FIG. **5** illustrates a BA session transfer in accordance with an embodiment.

[0033] FIG. **6** illustrates a BA session setup at a target AP in accordance with an embodiment.

[0034] FIG. **7** illustrates a flow chart of an example process for a BA session transfer by a non-AP STA in accordance with an embodiment.

[0035] FIG. **8** illustrates a flow chart of an example process for a BA session transfer by an AP in accordance with an embodiment.

[0036] In one or more implementations, not all of the depicted components in each figure may be required, and one or more implementations may include additional components not shown in a figure. Variations in the arrangement and type of the components may be made without departing from the scope of the subject disclosure. Additional components, different components, or fewer components may be utilized within the scope of the subject disclosure.

DETAILED DESCRIPTION

[0037] The detailed description set forth below, in connection with the appended drawings, is intended as a description of various implementations and is not intended to represent the only implementations in which the subject technology may be practiced. Rather, the detailed description includes specific details for the purpose of providing a thorough understanding of the inventive subject matter. As those skilled in the art would realize, the described implementations may be modified in various ways, all without departing from the scope of the present disclosure. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements.

[0038] The following description is directed to certain implementations for the purpose of describing the innovative aspects of this disclosure. However, a person having ordinary skill in the art will readily recognize that the teachings herein can be applied in a multitude of different ways. The examples in this disclosure are based on WLAN communication according to the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard, including IEEE 802.11be standard and any future amendments to the IEEE 802.11 standard. However, the described embodiments may be implemented in any device, system or network that is capable of transmitting and receiving radio frequency (RF) signals according to the IEEE 802.11 standard, the Bluetooth standard, Global System for Mobile communications (GSM), GSM/General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE), Terrestrial Trunked Radio (TETRA), Wideband-CDMA (W-CDMA), Evolution Data Optimized (EV-DO), 1×EV-DO, EV-DO Rev A, EV-DO Rev B, High Speed Packet Access (HSPA), High Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA), Evolved High Speed Packet Access (HSPA+), Long Term Evolution (LTE), 5G NR (New Radio), AMPS, or other known signals that are used to communicate within a wireless, cellular or internet of things (IoT) network, such as a system utilizing 3G, 4G, 5G, 6G, or further implementations thereof, technology.

[0039] Depending on the network type, other well-known terms may be used instead of "access point" or "AP," such as "router" or "gateway." For the sake of convenience, the term "AP" is used in this disclosure to refer to network infrastructure components that provide wireless access to remote terminals. In WLAN, given that the AP also contends for the wireless channel, the AP may also be referred to as a STA. Also, depending on the network type, other well-known terms may be used instead of "station" or "STA," such as "mobile station," "subscriber station," "remote terminal," "user equipment," "wireless terminal," or "user device." For the sake of convenience, the terms "station" and "STA" are used in this disclosure to refer to remote wireless equipment that wirelessly accesses an AP or contends for a wireless channel in a WLAN, whether the STA is a mobile device (such as a mobile telephone or smartphone) or is normally considered a stationary device (such as a desktop computer, AP, media player, stationary sensor, television, etc.).

[0040] Multi-link operation (MLO) is a key feature that is currently being developed by the standards body for next generation extremely high throughput (EHT) Wi-Fi systems in IEEE 802.11be. The Wi-Fi devices that support MLO are referred to as multi-link devices (MLD). With MLO, it is possible for a non-AP MLD to discover, authenticate, associate, and set up multiple links with an AP MLD. Channel access and frame exchange is possible on each link between the AP MLD and non-AP MLD.

[0041] FIG. **1** shows an example of a wireless network **100** in accordance with an embodiment. The embodiment of the wireless network **100** shown in FIG. **1** is for illustrative purposes only. Other embodiments of the wireless network **100** could be used without departing from the scope of this disclosure.

[0042] As shown in FIG. **1**, the wireless network **100** may include a plurality of wireless communication devices. Each wireless communication device may include one or more stations (STAs). The STA may be a logical entity that is a singly addressable instance of a medium access control (MAC) layer and a physical (PHY) layer interface to the wireless medium. The STA may be classified into an access point (AP) STA and a non-access point (non-AP) STA. The AP STA may be an entity that provides access to the distribution system service via the wireless medium for associated STAs. The non-AP STA may be a STA that is not contained within an AP-STA. For the sake of simplicity of description, an AP STA may be referred to as an AP and a non-AP STA may be referred to as a STA. In the example of FIG. **1**, APs **101** and **103** are wireless communication devices, each of which may include one or more AP STAs. In such embodiments, APs **101** and **103** may be AP multi-link device (MLD). Similarly, STAs **111**-**114** are wireless communication devices, each of which may include one or more non-AP STAs. In such embodiments, STAs **111**-**114** may be non-AP MLD.

[0043] The APs **101** and **103** communicate with at least one network **130**, such as the Internet, a proprietary Internet Protocol (IP) network, or other data network. The AP **101** provides wireless access to the network **130** for a plurality of stations (STAs) **111**-**114** with a coverage are 120 of the AP **101**. The APs **101** and **103** may communicate with each other and with the STAs using Wi-Fi or other WLAN communication techniques.

[0044] Depending on the network type, other well-known terms may be used instead of "access point" or "AP," such as "router" or "gateway." For the sake of convenience, the term "AP" is used in this disclosure to refer to network infrastructure components that provide wireless access to remote terminals. In WLAN, given that the AP also contends for the wireless channel, the AP may also be referred to as a STA. Also, depending on the network type, other well-known terms may be used instead of "station" or "STA," such as "mobile station," "subscriber station," "remote terminal," "user equipment," "wireless terminal," or "user device." For the sake of convenience, the terms "station" and "STA" are used in this disclosure to refer to remote wireless equipment that wirelessly accesses an AP or contends for a wireless channel in a WLAN, whether the STA is a mobile device (such as a mobile telephone or smartphone) or is normally considered a stationary device (such as a desktop computer, AP, media player, stationary sensor, television, etc.).

[0045] In FIG. **1**, dotted lines show the approximate extents of the coverage area **120** and **125** of APs **101** and **103**, which are shown as approximately circular for the purposes of illustration and explanation. It should be clearly understood that coverage areas associated with APs, such as the coverage areas **120** and **125**, may have other shapes, including irregular shapes, depending on the configuration of the APs.

[0046] As described in more detail below, one or more of the APs may include circuitry and/or programming for management of MU-MIMO and OFDMA channel sounding in WLANs. Although FIG. **1** shows one example of a wireless network **100**, various changes may be made to FIG. **1**. For example, the wireless network **100** could include any number of APs and any number of STAs in any suitable arrangement. Also, the AP **101** could communicate directly with any number of STAs and provide those STAs with wireless broadband access to the network **130**. Similarly, each AP **101** and **103** could communicate directly with the network **130** and provides STAs with direct wireless broadband access to the network **130**. Further, the APs **101** and/or **103** could provide access to other or additional external networks, such as external telephone networks or other types of data networks.

[0047] FIG. **2**A shows an example of AP **101** in accordance with an embodiment. The embodiment of the AP **101** shown in FIG. **2**A is for illustrative purposes, and the AP **103** of FIG. **1** could have the same or similar configuration. However, APs come in a wide range of configurations, and FIG. **2**A does not limit the scope of this disclosure to any particular implementations of an AP.

[0048] As shown in FIG. **2**A, the AP **101** may include multiple antennas **204*a*-204*n***, multiple radio frequency (RF) transceivers **209*a*-209*n***, transmit (TX) processing circuitry **214**, and receive (RX) processing circuitry **219**. The AP **101** also may include a controller/processor **224**, a memory **229**, and a backhaul or network interface **234**. The RF transceivers **209*a*-209*n*** receive, from the antennas **204*a*-204*n***, incoming RF signals, such as signals transmitted by STAs in the network **100**. The RF transceivers **209*a*-209*n*** down-convert the incoming RF signals to generate intermediate (IF) or baseband signals. The IF or baseband signals are sent to the RX processing circuitry **219**, which generates processed baseband signals by filtering, decoding, and/or digitizing the baseband or IF signals. The RX processing circuitry **219** transmits the processed baseband signals to the controller/processor **224** for further processing.

[0049] The TX processing circuitry **214** receives analog or digital data (such as voice data, web data, e-mail, or interactive video game data) from the controller/processor **224**. The TX processing circuitry **214** encodes, multiplexes, and/or digitizes the outgoing baseband data to generate processed baseband or IF signals. The RF transceivers **209*a*-209*n*** receive the outgoing processed baseband or IF signals from the TX processing circuitry **214** and up-converts the baseband or IF signals to RF signals that are transmitted via the antennas **204*a*-204*n***.

[0050] The controller/processor **224** can include one or more processors or other processing devices that control the overall operation of the AP **101**. For example, the controller/processor **224** could control the reception of uplink signals and the transmission of downlink signals by the RF transceivers **209*a*-209*n***, the RX processing circuitry **219**, and the TX processing circuitry **214** in accordance with well-known principles. The controller/processor **224** could support additional functions as well, such as more advanced wireless communication functions. For instance, the controller/processor **224** could support beam forming or directional routing operations in which outgoing signals from multiple antennas **204***a*-**204***n* are weighted differently to effectively steer the outgoing signals in a desired direction. The controller/processor **224** could also support OFDMA operations in which outgoing signals are assigned to different subsets of subcarriers for different recipients (e.g., different STAs **111**-**114**). Any of a wide variety of other functions could be supported in the AP **101** by the controller/processor **224** including a combination of DL MU-MIMO and OFDMA in the same transmit opportunity. In some embodiments, the controller/processor **224** may include at least one microprocessor or microcontroller. The controller/processor **224** is also capable of executing programs and other processes resident in the memory **229**, such as an OS. The controller/processor **224** can move data into or out of the memory **229** as required by an executing process.

[0051] The controller/processor **224** is also coupled to the backhaul or network interface **234**. The backhaul or network interface **234** allows the AP **101** to communicate with other devices or systems over a backhaul connection or over a network. The interface **234** could support communications over any suitable wired or wireless connection(s). For example, the interface **234** could allow the AP **101** to communicate over a wired or wireless local area network or over a wired or wireless connection to a larger network (such as the Internet). The interface **234** may include any suitable structure supporting communications over a wired or wireless connection, such as an Ethernet or RF transceiver. The memory **229** is coupled to the controller/processor **224**. Part of the memory **229** could include a RAM, and another part of the memory **229** could include a Flash memory or other ROM.

[0052] As described in more detail below, the AP **101** may include circuitry and/or programming for management of channel sounding procedures in WLANs. Although FIG. **2**A illustrates one example of AP **101**, various changes may be made to FIG. **2**A. For example, the AP **101** could include any number of each component shown in FIG. **2**A. As a particular example, an AP could include a number of interfaces **234**, and the controller/processor **224** could support routing functions to route data between different network addresses. As another example, while shown as including a single instance of TX processing circuitry **214** and a single instance of RX processing circuitry **219**, the AP **101** could include multiple instances of each (such as one per RF transceiver). Alternatively, only one antenna and RF transceiver path may be included, such as in legacy APs. Also, various components in FIG. **2**A could be combined, further subdivided, or omitted and additional components could be added according to particular needs.

[0053] As shown in FIG. **2**A, in some embodiment, the AP **101** may be an AP MLD that includes multiple APs **202***a*-**202***n*. Each AP **202***a*-**202***n* is affiliated with the AP MLD **101** and includes multiple antennas **204***a*-**204***n*, multiple radio frequency (RF) transceivers **209***a*-**209***n*, transmit (TX) processing circuitry **214**, and receive (RX) processing circuitry **219**. Each APs **202***a*-**202***n* may independently communicate with the controller/processor **224** and other components of the AP MLD **101**. FIG. **2**A shows that each AP **202***a*-**202***n* has separate multiple antennas, but each AP **202***a*-**202***n* can share multiple antennas **204***a*-**204***n* without needing separate multiple antennas. Each AP **202***a*-**202***n* may represent a physical (PHY) layer and a lower media access control (MAC) layer.

[0054] FIG. **2**B shows an example of STA **111** in accordance with an embodiment. The embodiment of the STA **111** shown in FIG. **2**B is for illustrative purposes, and the STAs **111**-**114** of FIG. **1** could have the same or similar configuration. However, STAs come in a wide variety of configurations, and FIG. **2**B does not limit the scope of this disclosure to any particular implementation of a STA.

[0055] As shown in FIG. **2**B, the STA **111** may include antenna(s) **205**, a RF transceiver **210**, TX processing circuitry **215**, a microphone **220**, and RX processing circuitry **225**. The STA **111** also may include a speaker **230**, a controller/processor **240**, an input/output (I/O) interface (IF) **245**, a touchscreen **250**, a display **255**, and a memory **260**. The memory **260** may include an operating system (OS) **261** and one or more applications **262**.

[0056] The RF transceiver **210** receives, from the antenna (s) **205**, an incoming RF signal transmitted by an AP of the network **100**. The RF transceiver **210** down-converts the incoming RF signal to generate an IF or baseband signal. The IF or baseband signal is sent to the RX processing circuitry **225**, which generates a processed baseband signal by filtering, decoding, and/or digitizing the baseband or IF signal. The RX processing circuitry **225** transmits the processed baseband signal to the speaker **230** (such as for voice data) or to the controller/processor **240** for further processing (such as for web browsing data).

[0057] The TX processing circuitry **215** receives analog or digital voice data from the microphone **220** or other outgoing baseband data (such as web data, e-mail, or interactive video game data) from the controller/processor **240**. The TX processing circuitry **215** encodes, multiplexes, and/or digitizes the outgoing baseband data to generate a processed baseband or IF signal. The RF transceiver **210** receives the outgoing processed baseband or IF signal from the TX processing circuitry **215** and up-converts the baseband or IF signal to an RF signal that is transmitted via the antenna(s) **205**.

[0058] The controller/processor **240** can include one or more processors and execute the basic OS program **261** stored in the memory **260** in order to control the overall operation of the STA **111**. In one such operation, the controller/processor **240** controls the reception of downlink signals and the transmission of uplink signals by the RF transceiver **210**, the RX processing circuitry **225**, and the TX processing circuitry **215** in accordance with well-known principles. The controller/processor **240** can also include processing circuitry configured to provide management of channel sounding procedures in WLANs. In some embodiments, the controller/processor **240** may include at least one microprocessor or microcontroller.

[0059] The controller/processor **240** is also capable of executing other processes and programs resident in the memory **260**, such as operations for management of channel sounding procedures in WLANs. The controller/processor **240** can move data into or out of the memory **260** as required by an executing process. In some embodiments, the controller/processor **240** is configured to execute a plurality of applications **262**, such as applications for channel sounding, including feedback computation based on a received null data packet announcement (NDPA) and null data packet (NDP) and transmitting the beamforming feedback report in response to a trigger frame (TF). The controller/processor **240** can operate the plurality of applications **262** based on the OS program **261** or in response to a signal received from an AP. The controller/processor **240** is also coupled to the I/O interface **245**, which provides STA **111** with the ability to connect to other devices such as laptop computers and handheld computers. The I/O interface **245** is the communication path between these accessories and the main controller/processor **240**.

[0060] The controller/processor **240** is also coupled to the input **250** (such as touchscreen) and the display **255**. The operator of the STA **111** can use the input **250** to enter data into the STA **111**. The display **255** may be a liquid crystal display, light emitting diode display, or other display capable of rendering text and/or at least limited graphics, such as from web sites. The memory **260** is coupled to the controller/processor **240**. Part of the memory **260** could include a random access memory (RAM), and another part of the memory **260** could include a Flash memory or other read-only memory (ROM).

[0061] Although FIG. **2**B shows one example of STA **111**, various changes may be made to FIG. **2**B. For example, various components in FIG. **2**B could be combined, further subdivided, or omitted and additional components could be added according to particular needs. In particular examples, the STA **111** may include any number of antenna(s) **205** for MIMO communication with an AP **101**. In another example, the STA **111** may not include voice communication or the controller/processor **240** could be divided into multiple processors, such as one or more central processing units (CPUs) and one or more graphics processing units (GPUs). Also, while FIG. **2**B illustrates the STA **111** configured as a mobile telephone or smartphone, STAs could be configured to operate as other types of mobile or stationary devices.

[0062] As shown in FIG. **2**B, in some embodiment, the STA **111** may be a non-AP MLD that includes multiple STAs **203*a*-203*n***. Each STA **203*a*-203*n*** is affiliated with the non-AP MLD **111** and includes an antenna(s) **205**, a RF transceiver **210**, TX processing circuitry **215**, and RX processing circuitry **225**. Each STAs **203*a*-203*n*** may independently communicate with the controller/processor **240** and other components of the non-AP MLD **111**. FIG. **2**B shows that each STA **203*a*-203*n*** has a separate antenna, but each STA **203*a*-203*n*** can share the antenna **205** without needing separate antennas. Each STA **203*a*-203*n*** may represent a physical (PHY) layer and a lower media access control (MAC) layer.

[0063] FIG. **3** shows an example of multi-link communication operation in accordance with an embodiment. The multi-link communication operation may be usable in IEEE 802.11be standard and any future amendments to IEEE 802.11 standard. In FIG. **3**, an AP MLD **310** may be the wireless communication device **101** and **103** in FIG. **1** and a non-AP MLD **220** may be one of the wireless communication devices **111-114** in FIG. **1**.

[0064] As shown in FIG. **3**, the AP MLD **310** may include a plurality of affiliated APs, for example, including AP 1, AP 2, and AP 3. Each affiliated AP may include a PHY interface to wireless medium (Link 1, Link 2, or Link 3). The AP MLD **310** may include a single MAC service access point (SAP) **318** through which the affiliated APs of the AP MLD **310** communicate with a higher layer (Layer 3 or network layer). Each affiliated AP of the AP MLD **310** may have a MAC address (lower MAC address) different from any other affiliated APs of the AP MLD **310**. The AP MLD **310** may have a MLD MAC address (upper MAC address) and the affiliated APs share the single MAC SAP **318** to Layer 3. Thus, the affiliated APs share a single IP address, and Layer 3 recognizes the AP MLD **310** by assigning the single IP address.

[0065] The non-AP MLD **320** may include a plurality of affiliated STAs, for example, including STA 1, STA 2, and STA 3. Each affiliated STA may include a PHY interface to the wireless medium (Link 1, Link 2, or Link 3). The non-AP MLD **320** may include a single MAC SAP **328** through which the affiliated STAs of the non-AP MLD **320** communicate with a higher layer (Layer 3 or network layer). Each affiliated STA of the non-AP MLD **320** may have a MAC address (lower MAC address) different from any other affiliated STAs of the non-AP MLD **320**. The non-AP MLD **320** may have a MLD MAC address (upper MAC address) and the affiliated STAs share the single MAC SAP **328** to Layer 3. Thus, the affiliated STAs share a single IP address, and Layer 3 recognizes the non-AP MLD **320** by assigning the single IP address.

[0066] The AP MLD **310** and the non-AP MLD **320** may set up multiple links between their affiliate APs and STAs. In this example, the AP 1 and the STA 1 may set up Link 1 which operates in 2.4 GHz band. Similarly, the AP 2 and the STA 2 may set up Link 2 which operates in 5 GHZ band, and the AP 3 and the STA 3 may set up Link 3 which operates in 6 GHz band. Each link may enable channel access and frame exchange between the AP MLD **310** and the non-AP MLD **320** independently, which may increase date throughput and reduce latency. Upon associating with an AP MLD on a set of links (setup links), each non-AP device is assigned a unique association identifier (AID).

[0067] The following documents are hereby incorporated by reference in their entirety into the present disclosure as if fully set forth herein: i) IEEE 802.11-2020, "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications," ii) IEEE 802.11ax-2021, "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications," and iii) IEEE P802.11be/D5.0, "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications."

[0068] As users move around an environment while holding an STA device, a signal strength of the STA to its connected AP can vary. If a user movement causes a significant decrease in a signal strength, a handover may be necessary. During the process of handover, an STA may switch from its current associated AP to a new AP.

[0069] FIG. **4** illustrates stages of a mobility handover procedure in accordance with an embodiment. As shown in FIG. **4**, in legacy devices without any mobility support, the handover procedure may involve several steps, including a detection phase **401**, a search phase **403**, an 802.11 authentication phase **405**, an 802.11 association phase **407**, an 802.1X authentication phase **409**, and a 802.11 resource reservation phase **411**.

[0070] During the detection phase **401**, an STA may determine that there is a need for a handover. The procedures to detect a need for handover may be vendor specific. For instance, a particular vendor implementation can choose to trigger handover when the signal strength to the currently associated AP drops below a certain threshold.

[0071] The detection phase **401** may be followed by a search phase **403**. During the search phase **403**, the STA may search for new APs to associate with. During the search phase **403**, the STA may perform a scan of different channels to identify APs in the vicinity. This can be done either passively, for example, by listening to beacons on a particular channel, or actively, for example, by the use of probe request and response procedure.

[0072] After the scanning procedure is complete, the next step is to perform 802.11 authentication (open system/shared key based) **405**. Once the STA is authenticated, the next step is to perform 802.11 association **807**. Introduced in IEEE 802.1i amendment, the 802.1X authentication phase **409** may include an EAP authentication between the STA and a AAA server with the assistance of the AP. Finally, during the 802.11 resource reservation phase **411**, the STA may set up various resources at the new AP. For example, the STA can perform QoS reservation, BA setup, among other operations with the newly associated AP.

[0073] Typically, during a handover, there can be a disruption in the connection as the setup procedure operates in a break-before-make manner. This can cause an impact on user experience especially with multimedia services which can suffer from session disruptions due to the high delay encountered during handover procedure.

[0074] In order to reduce the handover delay, a number of procedures have been introduced in several standards. The focus of these procedures may be to remove or reduce the delay encountered in various steps of the handover procedure. In 2008, IEEE 802.11r standard introduced a fast transition roaming which may eliminate the need for the authentication step during the handover. In 2011, IEEE 802.11k introduced assisted roaming which reduces the search phase by allowing the STA to request the AP to send channel information of candidate neighbor APs. In 2011, IEEE 802.11v also introduced network assisted roaming to assist the search phase. In IEEE 802.11be, the fast BSS transition procedure was extended to cover the case of MLO operation. This procedure helps to reduce the delays encountered due to 802.11 resource reservation. However, the STA may still need to perform the association and authentication phases which can take e.g., 10s of ms.

[0075] Block Acknowledgement (ACK) session transfer procedures in accordance with this disclosure are described herein. In some embodiments, the Block ACK (BA) session and/or the parameters thereof can be transferred from one AP to another AP. A BA session transfer can be done pre-roaming, during roaming, or after roaming.

[0076] Pre-roaming BA session transfer procedures in accordance with this disclosure are described herein. In some embodiments, the non-AP STA or the AP can initiate a BA session transfer process before roaming happens. The process can be initiated by transfer of an indication message by the requesting entity. The indication message can include at least one or more of the information items as indicated in Table 1.

TABLE 1

Information item	Description
Roaming indication	An information item that can provide an indication of the intent to roam. Examples can be as shown in Table 2 below.
BA session indication	An information item that can indicate the BA session that can be transferred. e.g., dialog token or reference for the Add Block Acknowledgement (ADDBA) request frame corresponding to the BA session. This can make indicated for one session or for more than one session (e.g., as a list).
A-MSDU support indication	An information item that can provide an indication of the A-MSDU (MAC Service Data Unit) supported field. This field can be set to a value of 1 to indicate that the non-AP STA can support an A-MSDU carried in a quality of service (QoS) Data frame sent under this BA agreement and to 0 to indicate otherwise.
Block ACK policy indication	An information item that can indicate the block ACK policy for the BA session. e.g., immediate, HT-immediate BA.
Traffic stream indication	An information item that can indicate the traffic stream for which the BA session corresponds to. Examples can be as shown in Table 4 below.
Buffer size indication	An information item that can indicate the buffer size. This can provide guidance for the target AP to decide its reordering buffer.
BA parameter set field	An information item that can provide the BA parameter set field or one or more of the parameters therein.
BA timeout value	An information item that can provide the BA timeout value or a value that can indicate the timeout value for a BA agreement. The timeout value can indicate the duration, in time units (TUs), after which the BA setup can be terminated if there are no frame exchanges within this duration using the BA agreement.
Sequence number information	An information item that can provide sequence number information for the BA session. This can be the sequence number of the first or next MAC Service Data Unit (MSDU) that can be sent under this BA agreement.
GCR group address information	An information item that can provide the GCR group address element or one or more of the parameters therein.
Operation information	An information item that can indicate the operation parameters. For instance, this can be the multi-band element or one or more of the parameters therein which can indicate the frequency band, operating class, channel number for which the BA session applies.
Link information	An information item that can indicate the link(s) of the target AP to which the BA session has been transferred to. Example approaches of indicating the link information can be as shown in Table 3.

[0077] The above information items can be transmitted together or separately. They can be transmitted as a part of any existing frame or element or field or subfield in a standard or can be a part of newly defined ones.

[0078] Table 2 provides an example of intent indication parameters.

TABLE 2

Information item	Description
Bit	A bit that can take a predetermined value (e.g., 0) to make the intent and to another predetermined value (e.g., 1) otherwise.
A flag	A flag that can be set to make the intent and reset otherwise. It can also be reset to make the intent and set otherwise.
Reason code	A reason code that can indicate the reason for the transmission of the message as making an indication to roam.

[0079] Table 3 provides example information items that can indicate link information.

TABLE 3

Information item	Description
Link ID list	A list of the applicable link IDs. This can be the link IDs of the target AP or the link IDs together with another differentiation parameter such as a collocated set ID.
Link ID bitmap	A link ID bitmap which can be used to make the indication. Setting the ith bit of this bitmap to a value of 1 can imply that the session can be transferred to the link of the target AP MLD with link ID equal to i and setting a value of 0 in the ith position of this bitmap can imply that the session cannot be transferred or does not apply to a link of the target AP MLD with link ID equal to i.

[0080] Table 4 provides examples of traffic stream indication parameters.

TABLE 4

Information item	Description
TID	The Traffic Identifier (TID) of the traffic stream.
SCSID	The Stream Classification Service Identifier (SCSID) for the traffic stream.
Classifier	The classifier mask to classify the traffic stream. e.g., Traffic Classification (TCLAS) element(s) along with TCLAS processing element.

[0081] In some embodiments, upon initiation of the transfer procedure, either the current AP or the non-AP STA can initiate the transfer. When the current AP initiates the transfer, the current AP can do so either over the wired network or over the air. When the non-AP STA transfers the BA session, it can do so over the air by sending the indication message to the target AP.

[0082] In some embodiments, upon receiving the indication message, the target AP (which may be referred to as the new AP herein) can generate a response message that can be transmitted to the non-AP STA. The response message can include at least one or more of the information items as indicated in Table 5.

[0083] Table 5 provides an example of information items that can be present in a response message.

TABLE 5

Information item	Description
Response to requested parameters in indication message	One or more information item(s) that can describe the response values for the parameters mentioned in the request message. e.g., the final values of the parameters in Table 1.
Deadline for roaming	An information item that can provide a deadline to roam to the target AP. If the non-AP does not roam to the target AP prior this deadline, the BA session transfer can be considered to be void or terminated and a new transfer/setup may need to be initiated.

[0084] The above information items can be transmitted together or separately. They can be transmitted as a part of any existing frame/element/field/subfield in the standard or can be a part of newly defined ones.

[0085] FIG. **5** illustrates a BA session transfer in accordance with an embodiment. Although one or more operations are described or shown in particular sequential order, in other embodiments the operations may be rearranged in a different order, which may include performance of multiple operations in at least partially overlapping time periods. In particular, FIG. **5** illustrates communications among a non-AP STA, a current AP, and a target AP. The non-AP STA transmits to the current AP an indication message **501** that requests a BA session transfer. In some embodiments, the indication message can include at least one or more of the information items as indicated in Table 1. In particular, the indication message may include a roaming indication that provides an indication of the intent to roam and a BA session indication that indicates the BA session to be transferred, among various other information.

[0086] Accordingly, the current AP communicates with the target AP to perform the BA session transfer **503**. Then, the current AP transmits to the non-AP STA a response message **505**. The response message can include at least one or more of the information items as indicated in Table 5. In particular, the response message may include a response to the requested parameters in the indication message (e.g., the final values for the parameters in Table 1), and a deadline for roaming that provides a deadline by which the non-AP STA needs to roam to the target AP.

[0087] BA transfer sessions during roaming in accordance with this disclosure are described herein. In some embodiments, either the non-AP STA or the AP can initiate the BA session transfer procedure during roaming. In some embodiments, when initiated during roaming, the non-AP STA or the AP can also provide an indication of the default mode to be used by the AP in case the BA session transfer requires more than a threshold duration of time. This can enable the non-AP STA to continue its data transfer in a default mode (e.g., using a basic BA mechanism instead of its variants) until the BA session has been setup with the target AP. In some embodiments, for the default mode, a sequence number may be reset at the target AP and one or more parameters associated with the BA session maybe reset. Upon setup of the BA at the target AP, the target AP can send a confirmation message to the non-AP STA to make the indication. Thereafter, the non-AP STA can use the BA session parameters for its operation.

[0088] In some embodiments, while the BA session transfer confirmation has not been received, the non-AP STA can continue to operate with the current AP.

[0089] In some embodiments, if the BA session transfer confirmation is not received within a timeout period, the non-AP STA can transition to the target AP and setup the BA session again.

[0090] In some embodiments, the BA session indication and response messages can be a part of the messages exchanged for initiating roaming.

[0091] BA transfer session after roaming in accordance with this disclosure are described herein. In some embodiments, after roaming, the non-AP STA can start its BA session setup procedure again. The non-AP STA can function in a basic operation mode while the BA session is not setup.

[0092] In some embodiments, the non-AP STA can make a request for transfer of a BA session from an old AP as long as the data continuity protocol results in clearance of buffered frames at the old AP. After the buffered frames at the old AP are transmitted to the non-AP STA or transferred to the target AP, the old AP can delete the BA session of the non-AP.

[0093] Transfer parameters in accordance with this disclosure are described herein. In some embodiments, when a BA session is transferred, one or more of the parameters shown in Table 6 can be transferred.

[0094] Table 6 provides an example of BA session parameters that can be transferred during roaming.

TABLE 6

Information item	Description
Latest sequence number	An information item that can provide the latest sequence number to be used.
AP side scoreboard parameters	One or more of the scoreboard parameters at the current AP. e.g., WinStart, WinEnd, among others. The effect of transferring these parameters can be that the target AP can start from the last state of the scoreboard at the current AP when the target AP starts to send frames to the non-AP.
Non-AP side scoreboard parameters	One or more of the scoreboard parameters at the non-AP STA. e.g., WinStart, WinEnd, among others. The effect of transferring these parameters can be that the non-AP STA can retain these parameters as it roams to a new AP and does not reset them. This can enable the non-AP to continue its communication from the last state as was with the current AP prior to roam.
BA session related parameters	An information item that can describe the parameters of the BA session. e.g., parameters negotiated during the ADDBA setup, parameters shown in Table 1, among others.

[0095] The above parameter transfer can either be carried out over the air or over the wired network.

[0096] Block ACK session setup procedures in accordance with this disclosure are described herein. In some embodiments, the non-AP STA can initiate a new BA session prior to roaming to a target AP. In some embodiments, the non-AP STA can transmit an indication message. This indication message can include at least one or more of the information items as indicated in Table 1 for the new BA session. In some embodiments, there can be an indication of the fact that this setup is for the target AP and not for the current AP. In some embodiments, the indication can be done via a new ADDBA frame which can be used during roaming to setup a new BA session at the target AP. Upon reception of this ADDBA message, the target AP can generate an ADDBA response message which can be transferred to the non-AP.

[0097] FIG. **6** illustrates an example procedure for BA session setup at a target AP in accordance with an embodiment. Although one or more operations are described or shown in particular sequential order, in other embodiments the operations may be rearranged in a different order, which may include performance of multiple operations in at least partially overlapping time periods. In particular, FIG. **6** illustrates communication among a non-AP STA, a current AP and a target AP. The non-AP STA transmits to the current AP an ADDBA request frame **601** to setup a new BA session at the target AP. Accordingly, the current AP communicates **603** with the target AP to setup the new BA session. In particular, upon reception of the ADDBA request frame **601**, the target AP can generate an ADDBA response message which can be transferred to the non-AP. Accordingly, the current AP transmits to the non-AP STA, the ADDBA response frame **605**.

[0098] Deleting a setup for transferred or setup BA session in accordance with this disclosure is described herein. In some embodiments, after a non-AP STA transfers the BA session or setups a new BA session at the target AP, the non-AP STA may want to cancel the BA session that is setup. For example, the application for whose traffic the BA session is setup is no longer running. In some embodiments, the non-AP STA can do so by transmitting a delete message. In some embodiments, there can be a modified Delete Block Ack (DELBA) frame that can carry an indication that the referred BA setup is at the target AP.

[0099] In some embodiments, a non-AP can make an indication to its current AP about its intent to reuse a BA setup at the target AP. The current AP can provide a confirmation with a transition time value. Following this, or prior to this, the current AP can move the BA session and related parameters to the target AP.

[0100] In some embodiments, the current AP can indicate to the non-AP STA about its intention to transfer the BA session and related parameters to a target AP. The current AP can provide a confirmation message to the non-AP STA upon completion of the transfer.

[0101] Capability advertisement in accordance with this disclosure is described herein. In some embodiments, an AP and/or non-AP STA that support BA session transfer procedures can advertise the capability. In some embodiments a capability advertisement may be made via a capability bit that can take a predetermined value (e.g., 1) to make the indication and another predetermined value (e.g., 0) to indicate otherwise. The capability advertisement can be done via management frames (e.g., beacons, probe response frames, among others for the AP and probe request, (Re) association request frame, among others by the non-AP).

[0102] In some embodiments, AP to AP Block Ack session transfer procedures can be carried out by the APs themselves. In some embodiments, AP to AP Block Ack session transfer procedures can be carried out by a logical entity that handles mobility management procedures.

[0103] FIG. **7** illustrates a flow chart of an example process for a BA session transfer by a non-AP STA in accordance with an embodiment. Although one or more operations are described or shown in particular sequential order, in other embodiments the operations may be rearranged in a different order, which may include performance of multiple operations in at least partially overlapping time periods. The flowchart depicted in FIG. **7** illustrates operations performed in an non-AP STA, such as the STA illustrated in FIG. **3**.

[0104] The process **700**, in operation **701**, the non-AP STA transmits, to a current AP, an indication message to transfer a BA session to a target AP. In some embodiments, the indication message can include at least one or more of the information items as indicated in Table 1. In particular, the indication message may include a roaming indication that provides an indication of the intent to roam and a BA session indication that indicates the BA session to be transferred, among various other information.

[0105] In operation **703**, the non-AP STA receives, from the current AP or the target AP, a response message. The response message can include at least one or more of the information items as indicated in Table 5. In particular, the response message may include a response to the requested parameters in the indication message (e.g., the final values for the parameters in Table 1), and a deadline for roaming that provides a deadline by which the non-AP STA needs to roam to the target AP.

[0106] In operation **705**, the non-AP STA communicates with the target AP.

[0107] FIG. **8** illustrates a flow chart of an example process for a BA session transfer by an AP in accordance with an embodiment. Although one or more operations are described or shown in particular sequential order, in other embodiments the operations may be rearranged in a different order, which may include performance of multiple operations in at least partially overlapping time periods. The flowchart depicted in FIG. **8** illustrates operations performed in an AP, such as the AP illustrated in FIG. **3**.

[0108] The process **800**, in operation **801**, the AP receives, from a non-AP STA, an indication message to transfer a BA session to a target AP. In some embodiments, the indication message can include at least one or more of the information items as indicated in Table 1. In particular, the indication message may include a roaming indication that provides an indication of the intent to roam and a BA session indication that indicates the BA session to be transferred, among various other information.

[0109] In operation **803**, the AP communicates with the target AP to perform the BA session transfer.

[0110] In operation **805**, the AP transmits to the non-AP STA, a response message regarding the BA session transfer. The response message can include at least one or more of the information items as indicated in Table 5. In particular, the response message may include a response to the requested parameters in the indication message (e.g., the final values for the parameters in Table 1), and a deadline for roaming that provides a deadline by which the non-AP STA needs to roam to the target AP. As described herein, embodiments in accordance with this disclosure may be applicable for multi-link operation and are not limited to single link operation.

[0111] Embodiments in accordance with this disclosure provide for BA session transfers between a current AP MLD and a target AP MLD, which provide for efficient wireless mobility management. In particular, embodiments in accordance with this disclosure allow for a non-AP STA to roam from a current AP MLD to a target AP MLD and a BA session can be transferred to the target AP and thus avoid having to terminate a BA session with the current AP and resetup a new BA session with the target AP, which minimizes disruptions or delays in services that would otherwise occur during these termination and setup procedures.

[0112] A 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. For example, "a" module may refer to one or more modules. An element proceeded by "a," "an," "the," or "said" does not, without further constraints, preclude the existence of additional same elements.

[0113] Headings and subheadings, if any, are used for convenience only and do not limit the invention. The word exemplary is used to mean serving as an example or illustration. To the extent that the term "include," "have," or the like is used, such term is intended to be inclusive in a manner similar to the term "comprise" as "comprise" is interpreted when employed as a transitional word in a claim. Relational terms such as first and second and the like may be used to distinguish one entity or action from another without necessarily requiring or implying any actual such relationship or order between such entities or actions.

[0114] Phrases such as an aspect, the aspect, another aspect, some aspects, one or more aspects, an implementation, the implementation, another implementation, some implementations, one or more implementations, an embodiment, the embodiment, another embodiment, some embodiments, one or more embodiments, a configuration, the configuration, another configuration, some configurations, one or more configurations, the subject technology, the disclosure, the present disclosure, other variations thereof and alike are for convenience and do not imply that a disclosure relating to such phrase(s) is essential to the subject technology or that such disclosure applies to all configurations of the subject technology. A disclosure relating to such phrase(s) may apply to all configurations, or one or more configurations. A disclosure relating to such phrase (s) may provide one or more examples. A phrase such as an aspect or some aspects may refer to one or more aspects and vice versa, and this applies similarly to other foregoing phrases.

[0115] A phrase "at least one of" preceding a series of items, with the terms "and" or "or" to separate any of the items, modifies the list as a whole, rather than each member of the list. The phrase "at least one of" does not require selection of at least one item; rather, the phrase allows a meaning that includes at least one of any one of the items, and/or at least one of any combination of the items, and/or at least one of each of the items. By way of example, each of the phrases "at least one of A, B, and C" or "at least one of A, B, or C" refers to only A, only B, or only C; any combination of A, B, and C; and/or at least one of each of A, B, and C.

[0116] It is understood that the specific order or hierarchy of steps, operations, or processes disclosed is an illustration of exemplary approaches. Unless explicitly stated otherwise, it is understood that the specific order or hierarchy of steps, operations, or processes may be performed in different order. Some of the steps, operations, or processes may be performed simultaneously or may be performed as a part of one or more other steps, operations, or processes. The accompanying method claims, if any, present elements of the various steps, operations or processes in a sample order, and are not meant to be limited to the specific order or hierarchy presented. These may be performed in serial, linearly, in parallel or in different order. It should be understood that the described instructions, operations, and systems can generally be integrated together in a single software/hardware product or packaged into multiple software/hardware products.

[0117] The disclosure is provided to enable any person skilled in the art to practice the various aspects described herein. In some instances, well-known structures and components are shown in block diagram form in order to avoid obscuring the concepts of the subject technology. The disclosure provides various examples of the subject technology, and the subject technology is not limited to these examples. Various modifications to these aspects will be readily apparent to those skilled in the art, and the principles described herein may be applied to other aspects.

[0118] 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, sixth paragraph, unless the element is expressly recited using a phrase means for or, in the case of a method claim, the element is recited using the phrase step for.

[0119] The title, background, brief description of the drawings, abstract, and drawings are hereby incorporated into the disclosure and are provided as illustrative examples of the disclosure, not as restrictive descriptions. It is submitted with the understanding that they will not be used to limit the scope or meaning of the claims. In addition, in the detailed description, it can be seen that the description provides illustrative examples and the various features are grouped together in various implementations for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed subject matter requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed configuration or operation. The following claims are hereby incorporated into the detailed description, with each claim standing on its own as a separately claimed subject matter.

[0120] The claims are not intended to be limited to the aspects described herein, but are to be accorded the full scope consistent with the language claims and to encompass all legal equivalents. Notwithstanding, none of the claims are intended to embrace subject matter that fails to satisfy the requirements of the applicable patent law, nor should they be interpreted in such a way.

What is claimed is:

1. A first access point (AP) in a wireless network, comprising:

a memory; and

a processor coupled to the memory, the processor configured to:

receive, from a station (STA), a first frame that that triggers a transfer of a block acknowledgement (BA) session to a second AP;

communicate with the second AP to transfer the BA session or at least one parameter associated with the BA session; and

transmit, to the STA, a second frame in response to the first.

2. The first AP of claim **1**, wherein the first frame includes at least one of an indication of an intent to roam from the first AP to the second AP, an indication of the BA session to be transferred, an indication that a sequence number or one or more parameters associated with the BA session can be reset at the second AP, or an indication of a traffic stream for which the BA session corresponds to.

3. The first AP of claim **1**, wherein the second frame includes a response to the first frame and an expiration time for the BA session, wherein the BA session does not go into effect if the STA fails to roam to the second AP.

4. The first AP of claim **1**, wherein the at least one parameter is: i) an information item that provides a latest sequence number to use, ii) an AP scoreboard parameter such that the second AP starts from a last state of the AP scoreboard parameter at the first AP when the second AP starts to send frames to the STA, iii) a STA scoreboard parameter such that the STA continues communication from a last state of the STA scoreboard parameter as with the first AP prior to roam, or iv) a BA session related parameter.

5. The first AP of claim **1**, wherein the second frame is transmitted after the BA session is setup with the second AP.

6. The first AP of claim **1**, wherein:

the first frame is received after roaming from the first AP to the second AP; and

wherein the processor is further configured to:

determine that all buffered frames are transmitted to the STA or the second AP; and

terminate the BA session with the STA based on a determination that all buffered frames are transmitted to the STA or the second AP.

7. The first AP of claim **1**, wherein the processor is further configured to:

transmit, to the STA, a third frame that indicates a capability to support the transfer of the BA session.

8. The first AP of claim **1**, wherein the first AP and the second AP are affiliated with a seamless roaming domain.

9. A first access point (AP) in a wireless network, comprising:

a memory; and

a processor coupled to the memory, the processor configured to:

receive, from a station (STA), a first frame that triggers a setup of a block acknowledgement (BA) session at a second AP;

communicate with the second AP to setup the BA session or at least one parameter associated with the BA session; and

transmit, to the STA, a second frame in response to the first frame.

10. The first AP of claim **9**, wherein the first frame indicates that the BA session setup is for the second AP.

11. The first AP of claim **9**, wherein the first frame is received prior to the STA roaming to the second AP and the first frame includes at least one of an indication of an intent to roam or a set of parameters for the BA session.

12. A station (STA) in a wireless network, comprising:

a memory; and

a processor coupled to the memory, the processor configured to:

transmit, to a first access point (AP), a first frame that triggers a transfer of a block acknowledgement (BA) session or at least one parameter associated with the BA session to a second AP;

receive, from the first AP or the second AP, a second frame in response to the first frame, wherein the first AP communicates with the second AP to transfer the BA session or the at least one parameter associated with the BA session.

13. The STA of claim **12**, wherein the first frame includes at least one of an indication of an intent to roam from the first AP to the second AP, an indication of the BA session to be transferred, an indication that a sequence number or one or more parameters associated with the BA session can be reset at the second AP, or an indication of a traffic stream for which the BA session corresponds to.

14. The STA of claim **12**, wherein the second frame includes a response to the first frame and an expiration time for the BA session, wherein the BA session does not go into effect if the STA fails to roam to the second AP.

15. The STA of claim **12**, wherein the at least one parameter is: i) an information item that provides a latest sequence number to use, ii) an AP scoreboard parameter such that the second AP starts from a last state of the AP scoreboard parameter at the first AP when the second AP starts to send frames to the STA, iii) a STA scoreboard parameter such that the STA continues communication from a last state of the STA scoreboard parameter as with the first AP prior to roam, or iv) a BA session related parameter.

16. The STA of claim **12**, wherein the second frame is received after the BA session is setup with the second AP.

17. The STA of claim **12**, wherein the first frame is transmitted after roaming from the first AP to the second AP, wherein the processor is further configured to:

receive, from the first AP, all buffered frames.

18. The STA of claim **12**, wherein the processor is further configured to:

receive, from the first AP, a third frame that indicates a capability to support the transfer of the BA session.

19. The STA of claim **12**, wherein the processor is further configured to:

transmit, to the second AP, a third frame that terminates the BA session.

20. The STA of claim **12**, wherein the first AP and the second AP are affiliated with a seamless roaming domain.

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