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(54) **METHOD AND APPARATUS FOR OPERATION PARAMETER UPDATE FOR EPCS**

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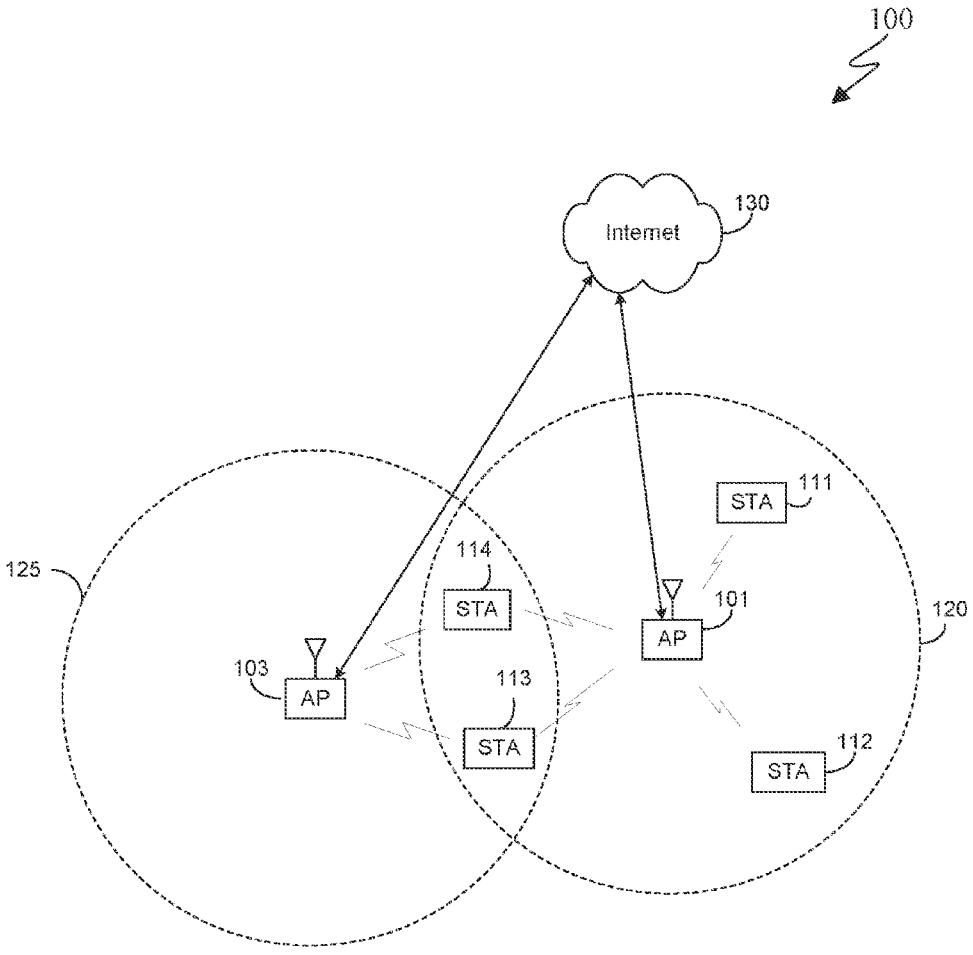
(57) **ABSTRACT**

Methods and apparatuses for an operation parameter update for emergency preparedness communication services (EPCS) operation are disclosed. A method for wireless communication performed by an access point (AP) multi-link device (MLD) that includes APs, the method comprising: forming a link with a corresponding station (STA) of a non-AP MLD; transmitting information associated with emergency preparedness communication services (EPCS) operation parameters to the corresponding STA; determining whether the EPCS operation parameters transmitted to the corresponding STA need to be updated; when the EPCS operation parameters transmitted to the corresponding STA do not need to be updated, continuing with current EPCS operation parameters; and when the EPCS operation parameters transmitted to the corresponding STA need to be updated, determining a procedure for updating the EPCS operation parameters.



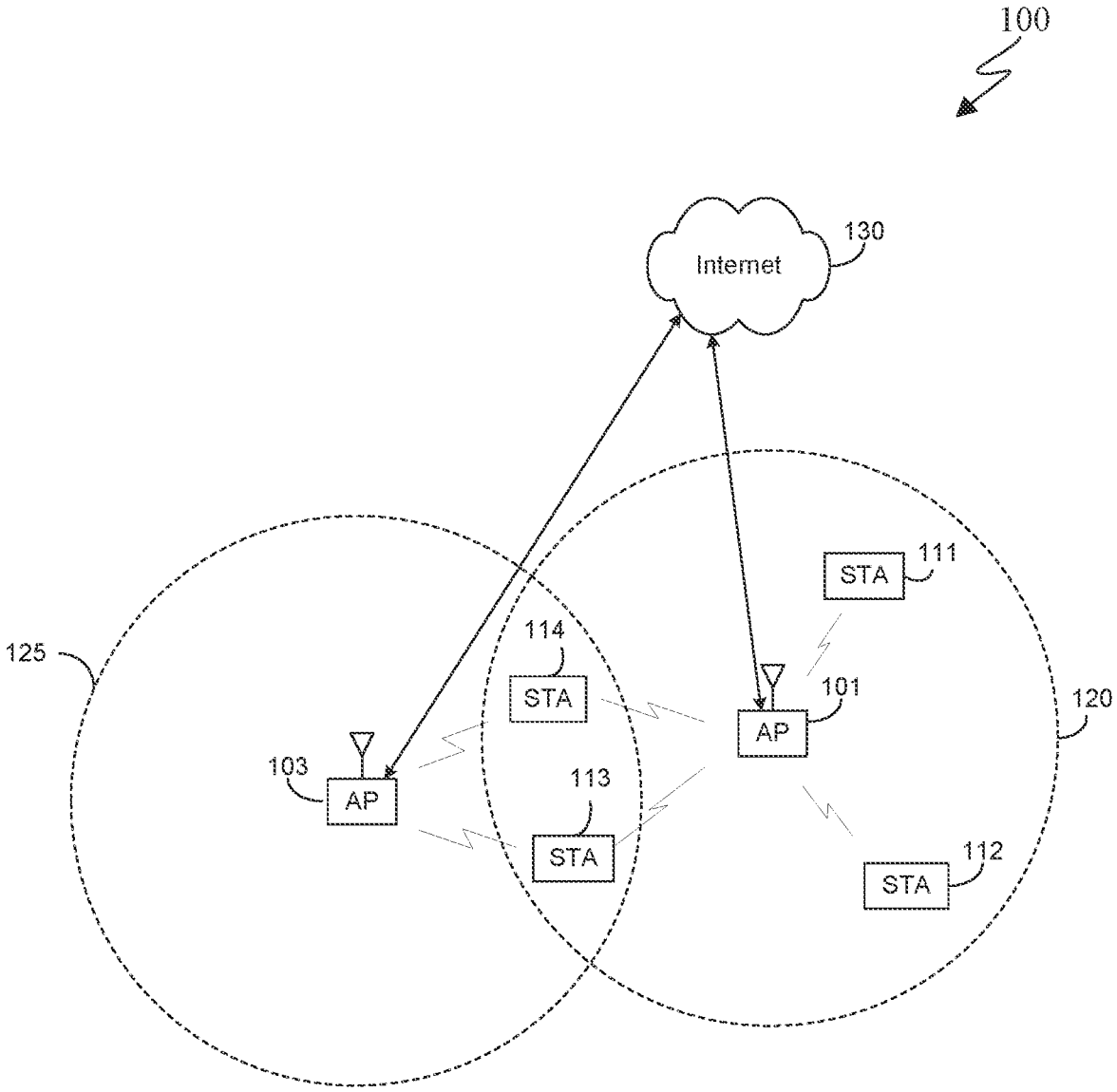

100
Internet
130
125
114
STA
111
STA
101
AP
120
103
AP
113
STA
112
STA

FIG. 1

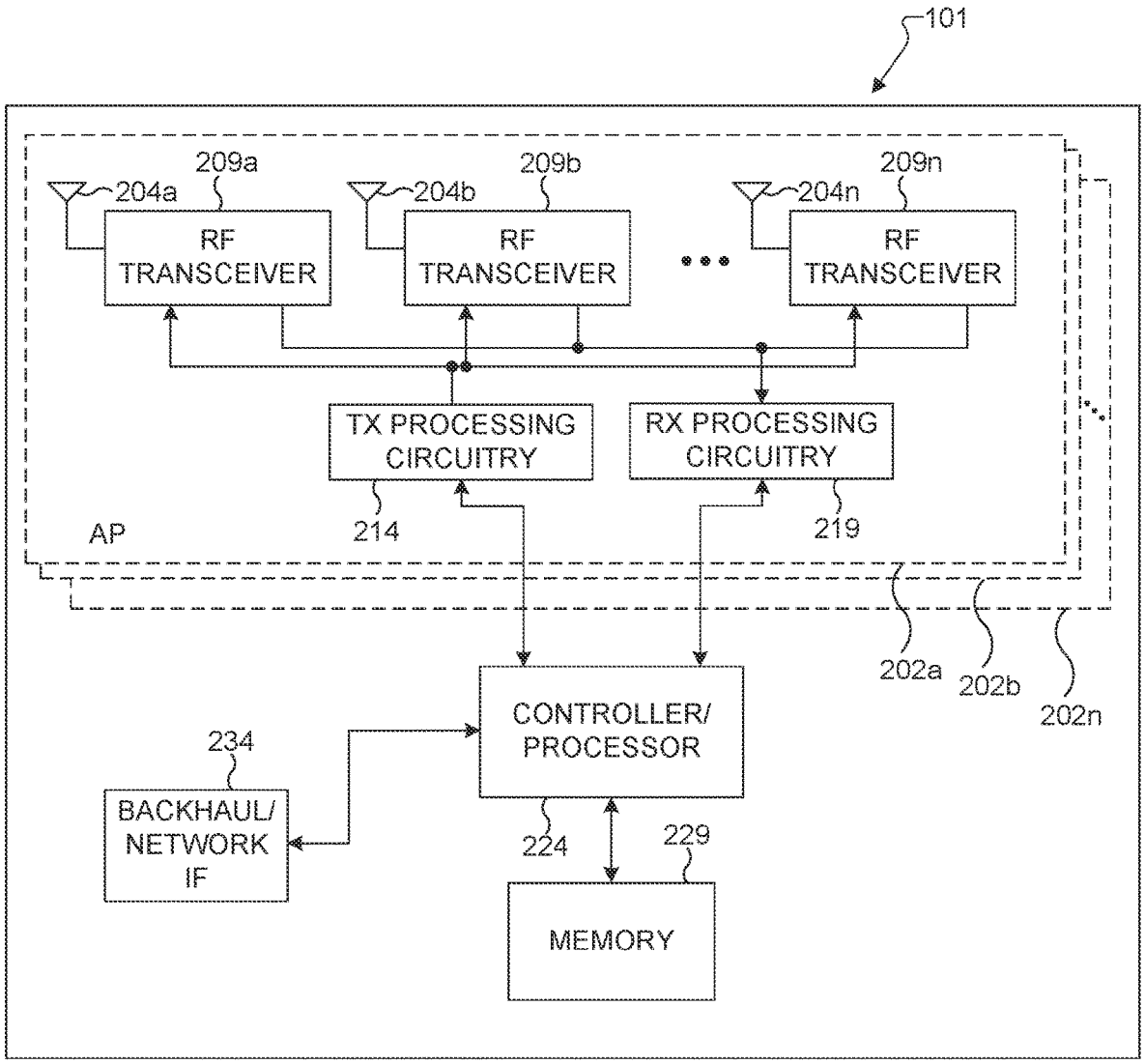

101
209a
204a
RF TRANSCEIVER
209b
204b
RF TRANSCEIVER
209n
204n
RF TRANSCEIVER
TX PROCESSING CIRCUITRY
214
RX PROCESSING CIRCUITRY
219
AP
202a
202b
202n
CONTROLLER/ PROCESSOR
234
BACKHAUL/ NETWORK IF
224
229
MEMORY

FIG. 2A

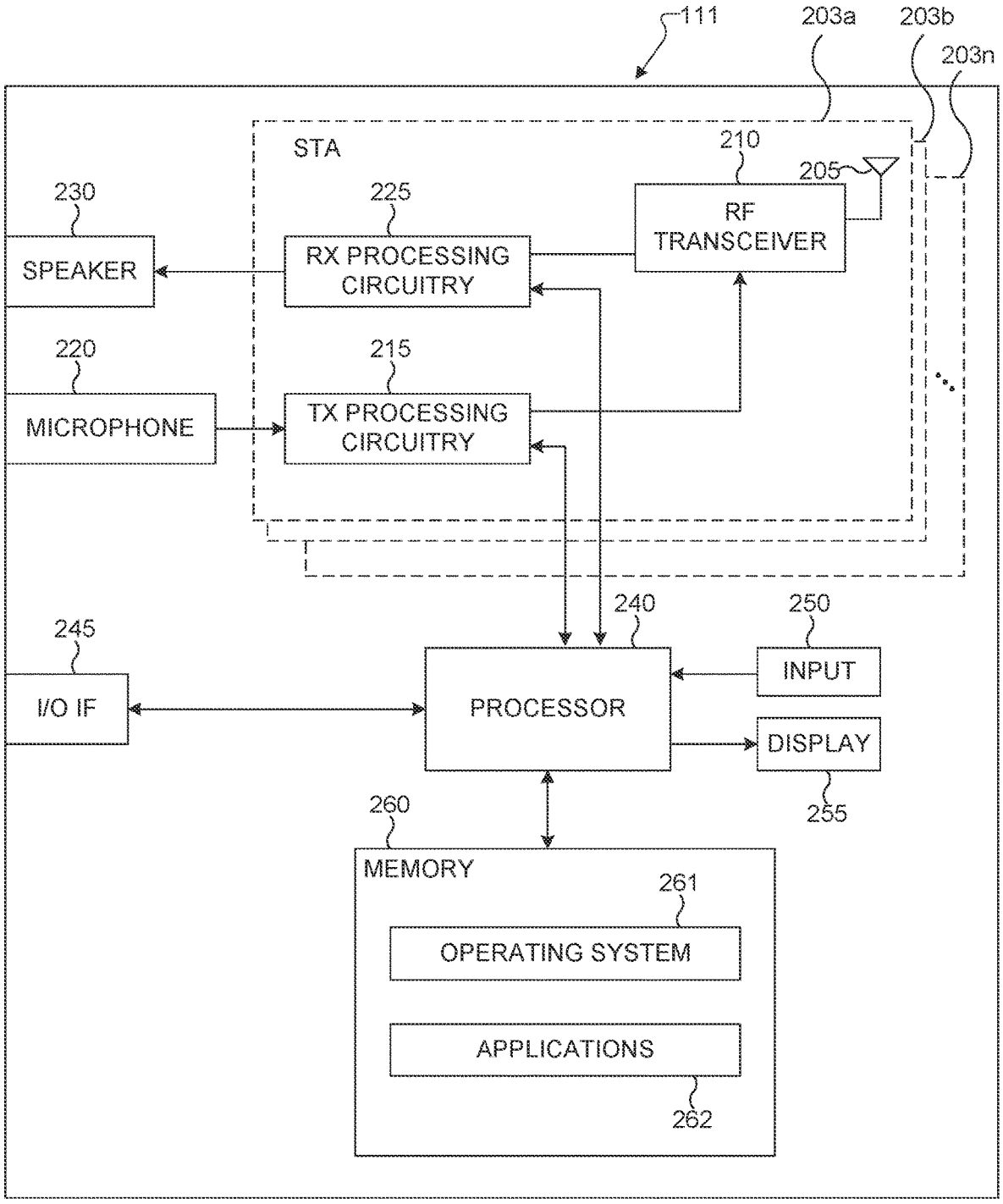

111
203a
203b
203n
STA
210
205
230
225
RF TRANSCEIVER
SPEAKER
RX PROCESSING CIRCUITRY
220
215
MICROPHONE
TX PROCESSING CIRCUITRY
240
250
245
INPUT
I/O IF
PROCESSOR
DISPLAY
255
260
MEMORY
261
OPERATING SYSTEM
APPLICATIONS
262

FIG. 2B

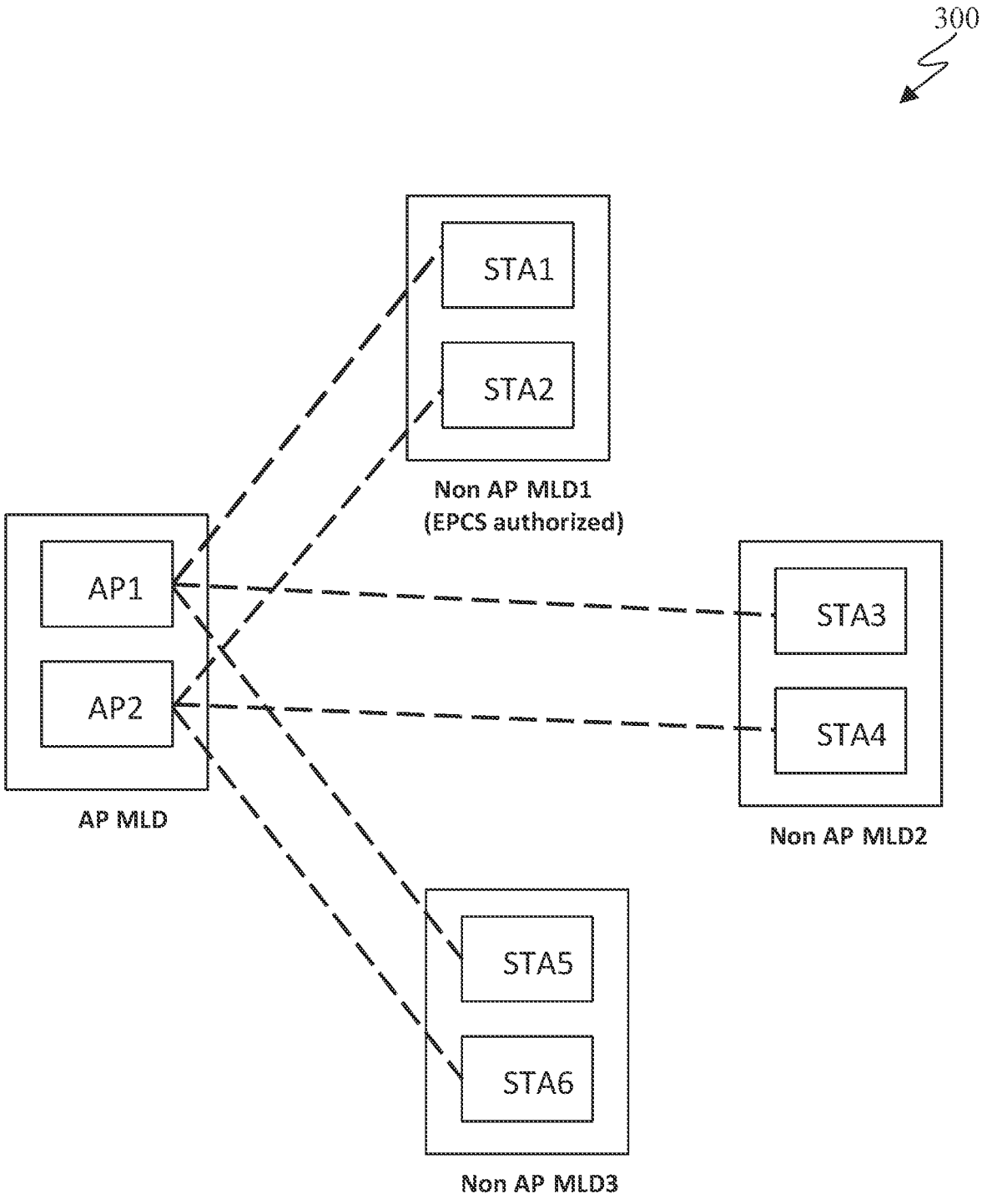

300
STA1
STA2
Non AP MLD1
(EPCS authorized)
AP1
AP2
AP MLD
STA3
STA4
Non AP MLD2
STA5
STA6
Non AP MLD3

FIG. 3

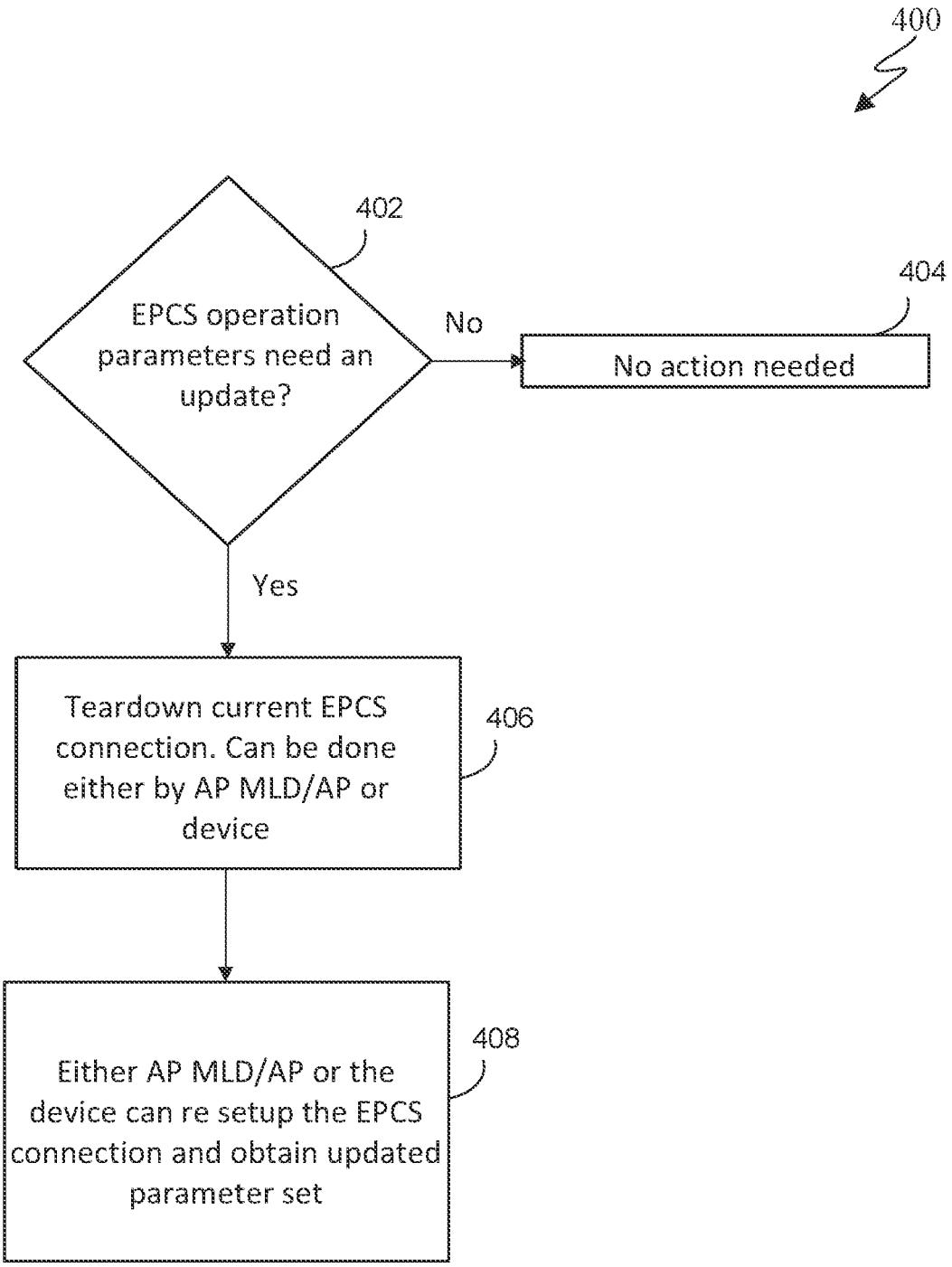

400
402
EPCS operation parameters need an update?
No
404
No action needed
Yes
Teardown current EPCS connection. Can be done either by AP MLD/AP or device
406
Either AP MLD/AP or the device can re setup the EPCS connection and obtain updated parameter set
408

FIG. 4

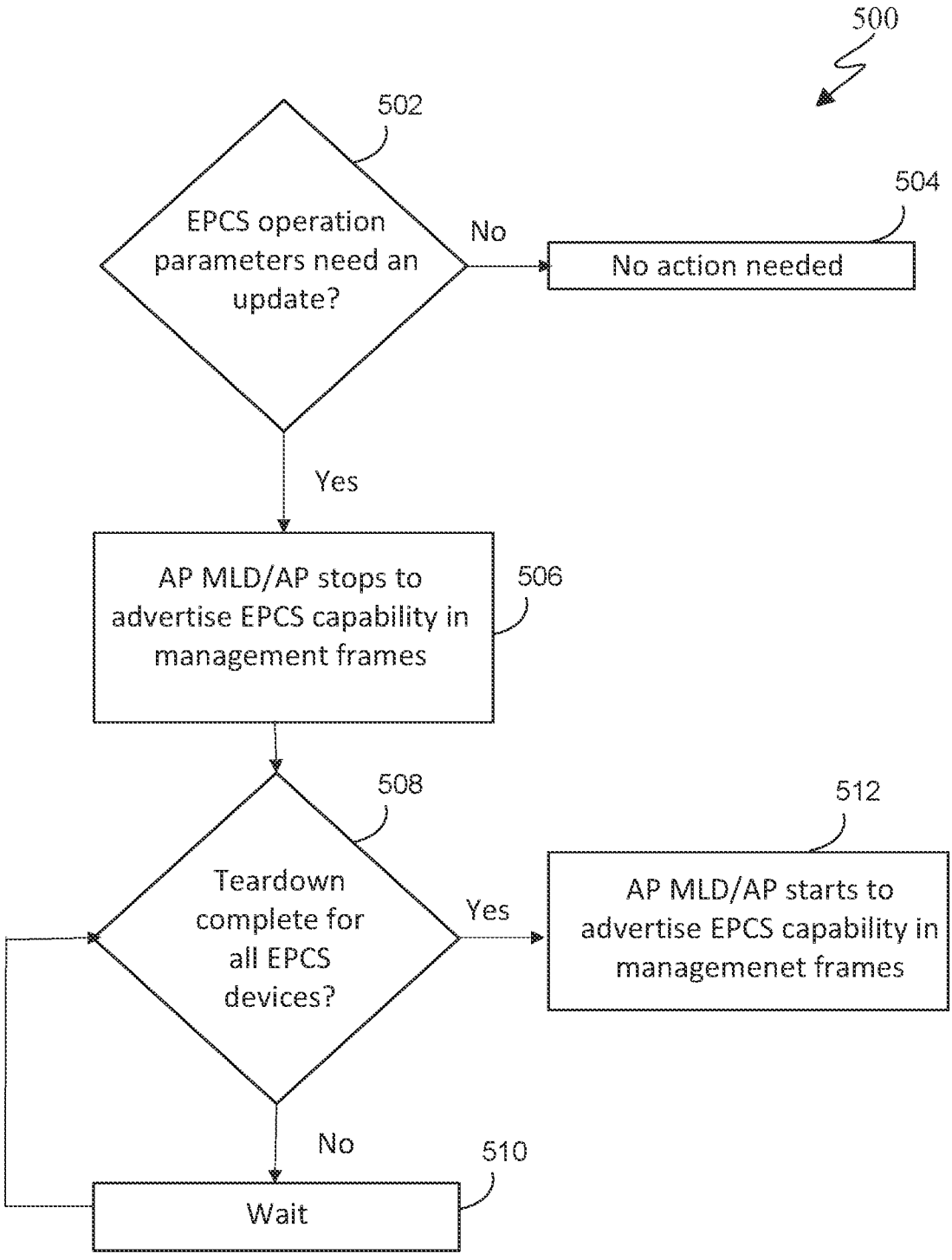

500
502
EPCS operation parameters need an update?
No
504
No action needed
Yes
AP MLD/AP stops to advertise EPCS capability in management frames
506
508
Teardown complete for all EPCS devices?
Yes
512
AP MLD/AP starts to advertise EPCS capability in managemenet frames
No
510
Wait

FIG. 5

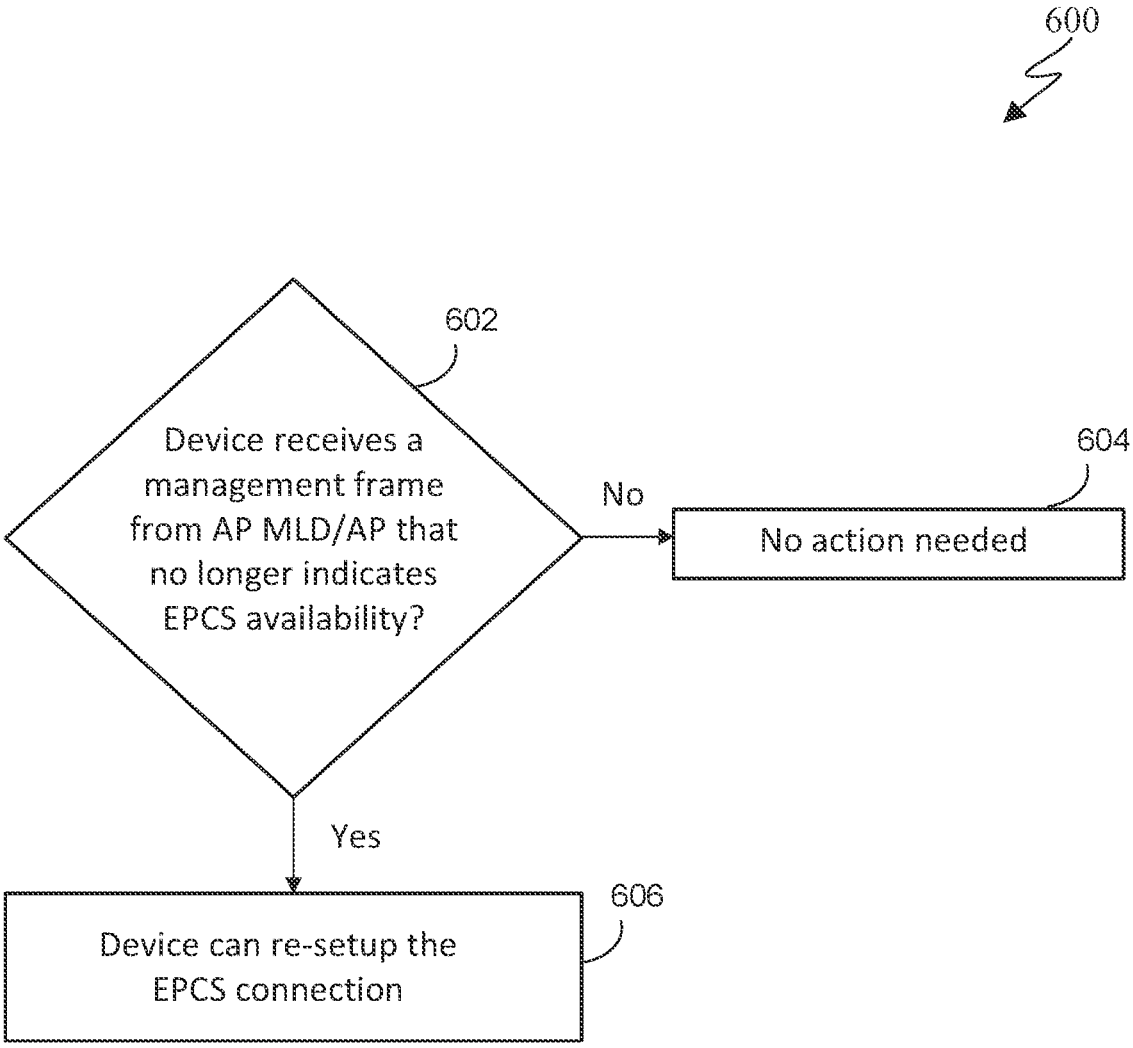

600
602
Device receives a management frame from AP MLD/AP that no longer indicates EPCS availability?
No
604
No action needed
Yes
606
Device can re-setup the EPCS connection

FIG. 6

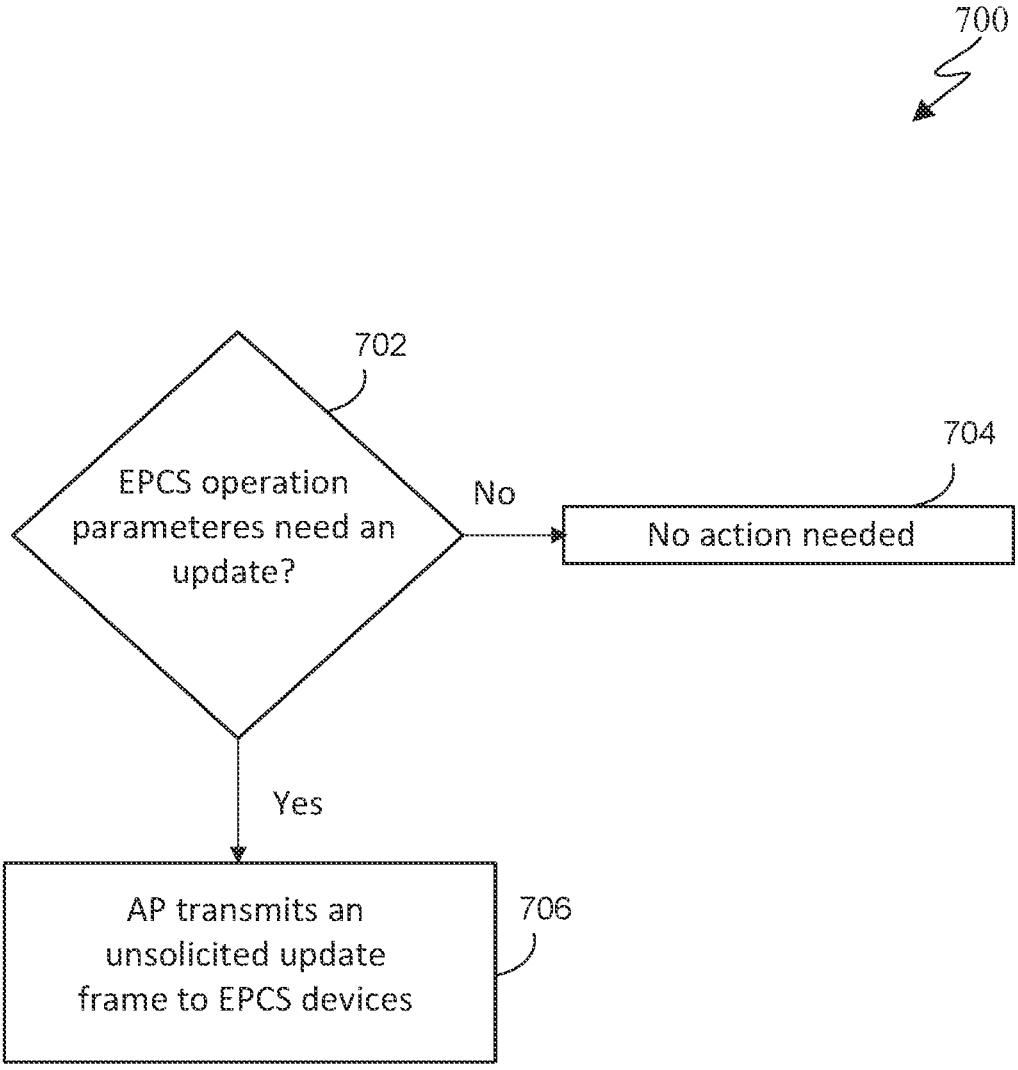

700
702
EPCS operation parameteres need an update?
No
704
No action needed
Yes
AP transmits an unsolicited update frame to EPCS devices
706

FIG. 7

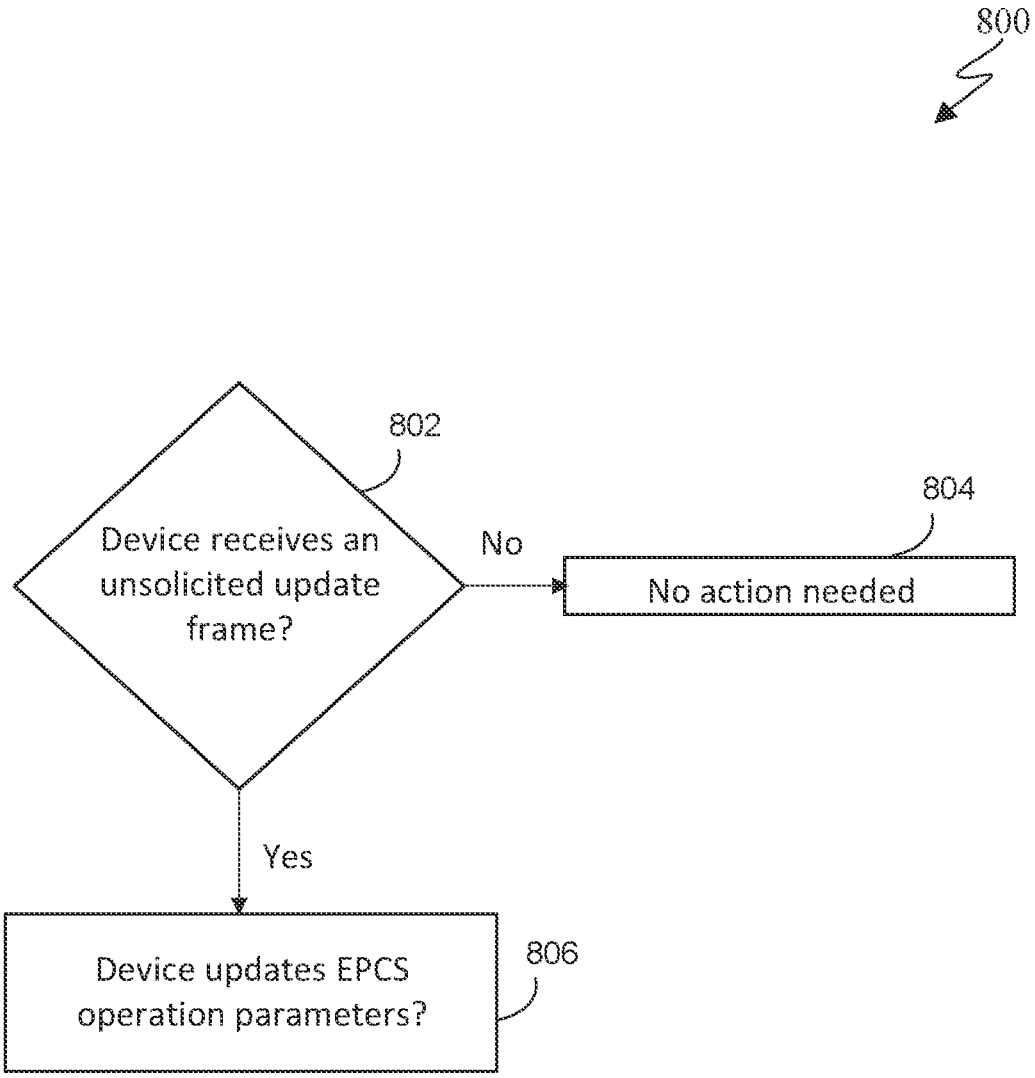

800
802
Device receives an unsolicited update frame?
No
804
No action needed
Yes
Device updates EPCS operation parameters?
806

FIG. 8

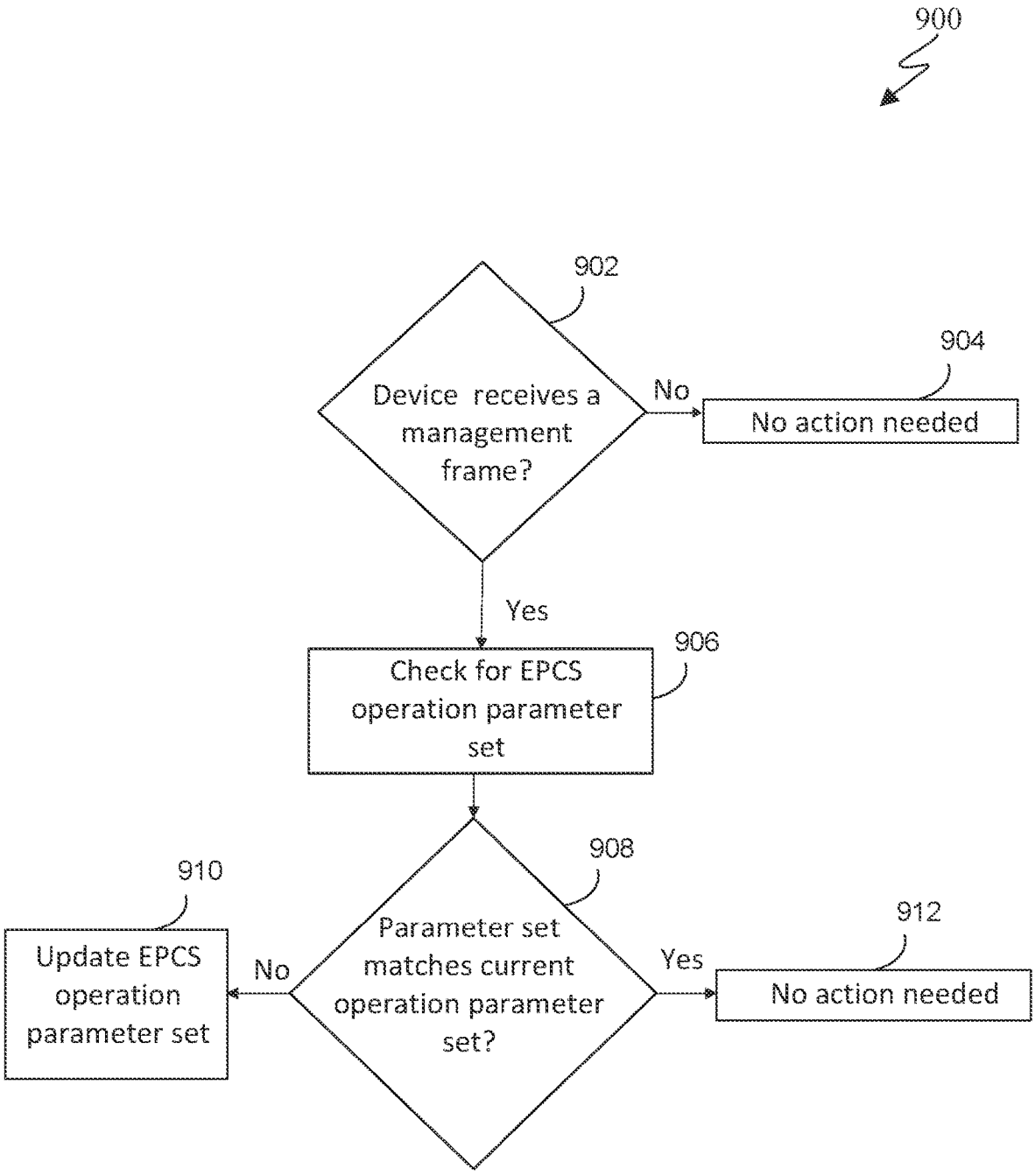

900
902
Device receives a management frame?
No
904
No action needed
Yes
906
Check for EPCS operation parameter set
908
Parameter set matches current operation parameter set?
No
910
Update EPCS operation parameter set
Yes
912
No action needed

FIG. 9

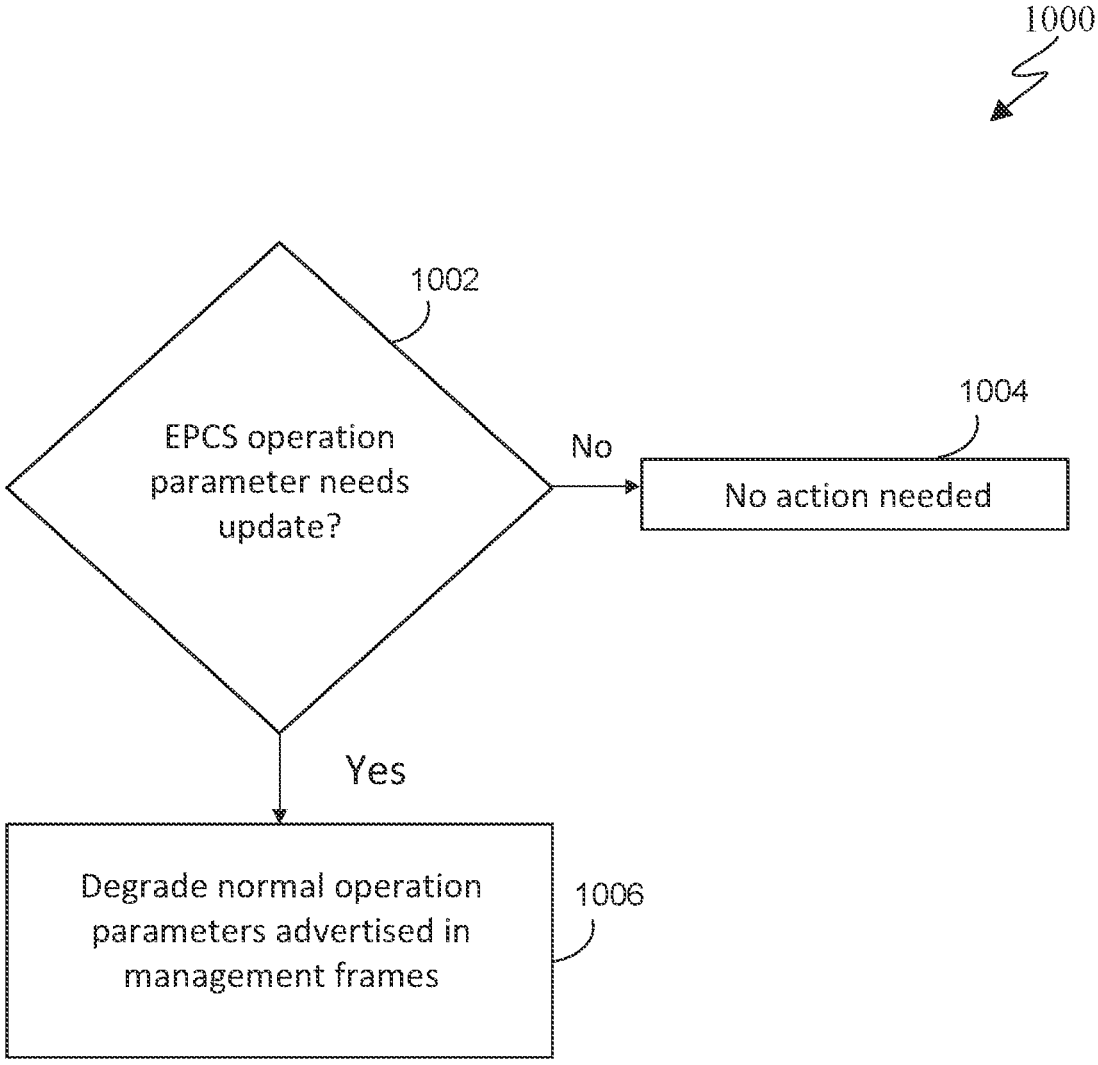

1000
1002
EPCS operation parameter needs update?
No
1004
No action needed
Yes
Degrade normal operation parameters advertised in management frames
1006

FIG. 10

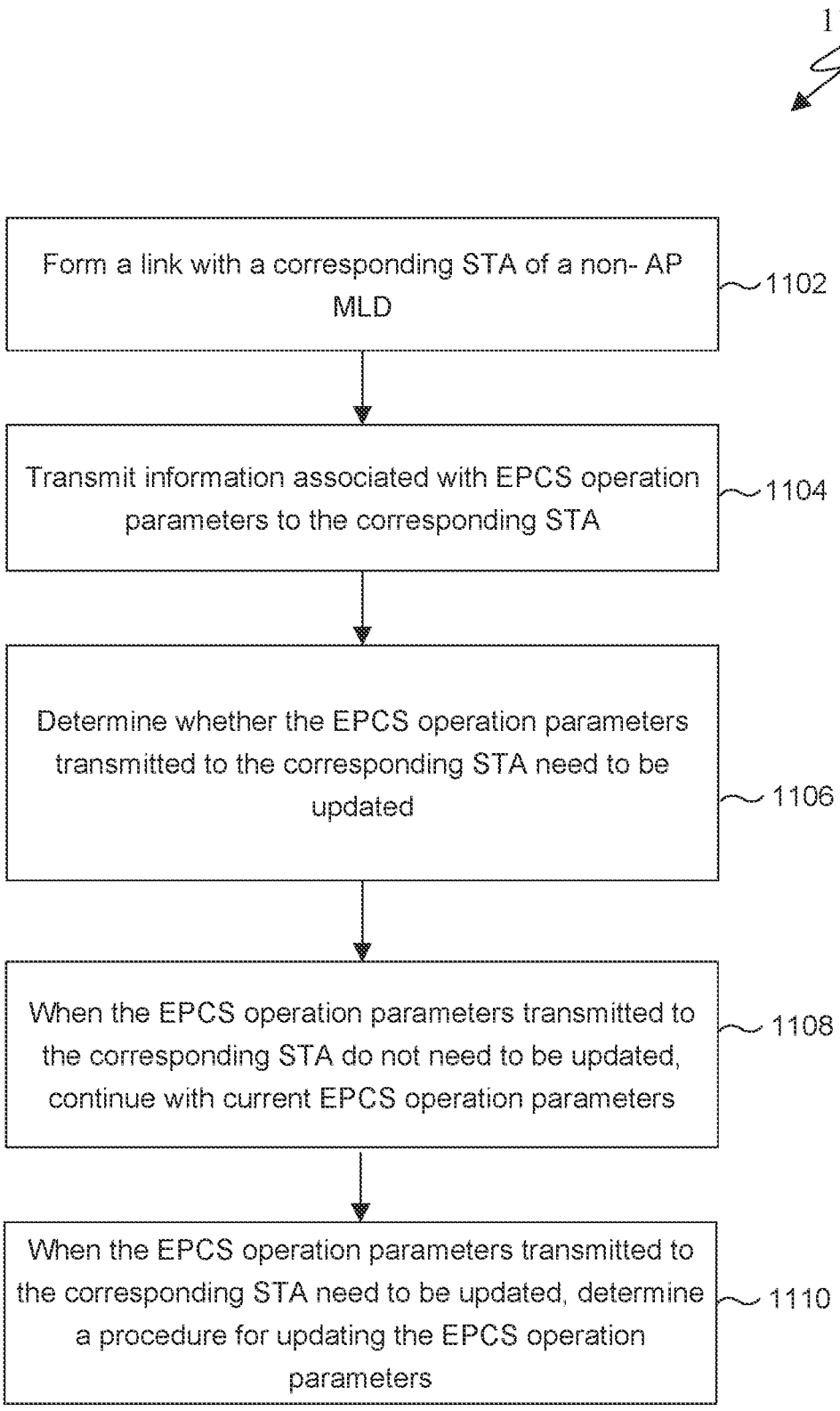

1100
Form a link with a corresponding STA of a non- AP MLD
1102
Transmit information associated with EPCS operation parameters to the corresponding STA
1104
Determine whether the EPCS operation parameters transmitted to the corresponding STA need to be updated
1106
When the EPCS operation parameters transmitted to the corresponding STA do not need to be updated, continue with current EPCS operation parameters
1108
When the EPCS operation parameters transmitted to the corresponding STA need to be updated, determine a procedure for updating the EPCS operation parameters
1110

FIG. 11

METHOD AND APPARATUS FOR OPERATION PARAMETER UPDATE FOR EPCS

CROSS-REFERENCE TO RELATED APPLICATION AND CLAIM OF PRIORITY

[0001] This application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application No. 63/395,572 filed on Aug. 5, 2022; U.S. Provisional Patent Application No. 63/417,891 filed on Oct. 20, 2022; and U.S. Provisional Patent Application No. 63/468,728 filed on May 24, 2023; which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

[0002] This disclosure relates generally to transmission efficiency in wireless communications systems that include multi-link devices. Embodiments of this disclosure relate to methods and apparatuses for an operation parameter update for emergency preparedness communication services (EPCS) operation.

BACKGROUND

[0003] Wireless local area network (WLAN) technology 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. The IEEE 802.11 family of standards aims to increase speed and reliability and to extend the operating range of wireless networks.

[0004] Multi-link operation (MLO) is a 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-access point (AP) multi-link device (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.

SUMMARY

[0005] Embodiments of the present disclosure provide methods and apparatuses for operation parameter update for EPCS operation.

[0006] In one embodiment, an access point (AP) multi-link device (MLD) comprises: APs, each comprising a transceiver configured to: form a link with a corresponding station (STA) of a non-AP MLD; and transmit information associated with emergency preparedness communication services (EPCS) operation parameters to the corresponding STA. The AP-MLD further comprises a processor operably coupled to the transceiver, the processor configured to: determine whether the EPCS operation parameters transmitted to the corresponding STA need to be updated; when the EPCS operation parameters transmitted to the corresponding STA do not need to be updated, continue with current EPCS operation parameters; and when the EPCS operation parameters transmitted to the corresponding STA need to be updated, determine a procedure for updating the EPCS operation parameters.

[0007] In another embodiment, a non-AP MLD comprises: STAs, each comprising a transceiver configured to: form a link with a corresponding AP of an AP MLD; and receive information associated with EPCS operation parameters from the corresponding AP. The non-AP MLD further comprises a processor operably coupled to the transceiver, the processor configured to: determine whether the EPCS operation parameters received from the corresponding AP need to be updated; when the EPCS operation parameters received from the corresponding AP do not need to be updated, continue with current EPCS operation parameters; and when the EPCS operation parameters received from the corresponding AP need to be updated, determine a procedure for updating the EPCS operation parameters.

[0008] In yet another embodiment, a method for wireless communication performed by an AP-MLD that includes APs, the method comprising: forming a link with a corresponding STA of a non-AP MLD; transmitting information associated with EPCS operation parameters to the corresponding STA; determining whether the EPCS operation parameters transmitted to the corresponding STA need to be updated; when the EPCS operation parameters transmitted to the corresponding STA do not need to be updated, continuing with current EPCS operation parameters; and when the EPCS operation parameters transmitted to the corresponding STA need to be updated, determining a procedure for updating the EPCS operation parameters.

[0009] Other technical features may be readily apparent to one skilled in the art from the following figures, descriptions, and claims.

[0010] Before undertaking the DETAILED DESCRIPTION below, it may be advantageous to set forth definitions of certain words and phrases used throughout this patent document. The term "couple" and its derivatives refer to any direct or indirect communication between two or more elements, whether or not those elements are in physical contact with one another. The terms "transmit," "receive," and "communicate," as well as derivatives thereof, encompass both direct and indirect communication. The terms "include" and "comprise," as well as derivatives thereof, mean inclusion without limitation. The term "or" is inclusive, meaning and/or. The phrase "associated with," as well as derivatives thereof, means to include, be included within, interconnect with, contain, be contained within, connect to or with, couple to or with, be communicable with, cooperate with, interleave, juxtapose, be proximate to, be bound to or with, have, have a property of, have a relationship to or with, or the like. The term "controller" means any device, system or part thereof that controls at least one operation. Such a controller may be implemented in hardware or a combination of hardware and software and/or firmware. The functionality associated with any particular controller may be centralized or distributed, whether locally or remotely. The phrase "at least one of," when used with a list of items, means that different combinations of one or more of the listed items may be used, and only one item in the list may be needed. For example, "at least one of: A, B, and C" includes any of the following combinations: A, B, C, A and B, A and C, B and C, and A and B and C. As used herein, such terms as "1st" and "2nd," or "first" and "second" may be used to simply distinguish a corresponding component from another and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively", as "coupled with," "coupled to," "connected with," or "con-

nected to" another element (e.g., a second element), it means that the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

[0011] As used herein, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

[0012] Moreover, various functions described below can be implemented or supported by one or more computer programs, each of which is formed from computer readable program code and embodied in a computer readable medium. The terms "application" and "program" refer to one or more computer programs, software components, sets of instructions, procedures, functions, objects, classes, instances, related data, or a portion thereof adapted for implementation in a suitable computer readable program code. The phrase "computer readable program code" includes any type of computer code, including source code, object code, and executable code. The phrase "computer readable medium" includes any type of medium capable of being accessed by a computer, such as read only memory (ROM), random access memory (RAM), a hard disk drive, a compact disc (CD), a digital video disc (DVD), or any other type of memory. A "non-transitory" computer readable medium excludes wired, wireless, optical, or other communication links that transport transitory electrical or other signals. A non-transitory computer readable medium includes media where data can be permanently stored and media where data can be stored and later overwritten, such as a rewritable optical disc or an erasable memory device.

[0013] Definitions for other certain words and phrases are provided throughout this patent document. Those of ordinary skill in the art should understand that in many if not most instances, such definitions apply to prior as well as future uses of such defined words and phrases.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] For a more complete understanding of the present disclosure and its advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, in which like reference numerals represent like parts:

[0015] FIG. **1** illustrates an example wireless network according to embodiments of the present disclosure;

[0016] FIG. **2**A illustrates an example AP according to embodiments of the present disclosure;

[0017] FIG. **2**B illustrates an example STA according to embodiments of the present disclosure;

[0018] FIG. **3** illustrates an example scenario involving EPCS authorized devices co-existing with non-EPCS devices according to embodiments of the present disclosure;

[0019] FIG. **4** illustrates an example method for explicit teardown and re-setup for EPCS operation according to embodiments of the present disclosure;

[0020] FIG. **5** illustrates an example method performed by an AP for implicit teardown and EPCS re-setup according to embodiments of the present disclosure;

[0021] FIG. **6** illustrates an example method performed by an STA for implicit teardown and EPCS re-setup according to embodiments of the present disclosure;

[0022] FIG. **7** illustrates an example method performed by an AP for transmission of an unsolicited update frame according to embodiments of the present disclosure;

[0023] FIG. **8** illustrates an example method performed by an STA for handling of an unsolicited update frame according to embodiments of the present disclosure;

[0024] FIG. **9** illustrates an example method for a management frame based EPCS operation parameter update according to embodiments of the present disclosure;

[0025] FIG. **10** illustrates an example method performed by an AP for degrading a normal operation parameter set according to embodiments of the present disclosure; and

[0026] FIG. **11** illustrates an example of a method for wireless communication performed by an AP device according to embodiments of the present disclosure.

DETAILED DESCRIPTION

[0027] FIGS. **1** through **11**, discussed below, and the various embodiments used to describe the principles of the present disclosure in this patent document are by way of illustration only and should not be construed in any way to limit the scope of the disclosure. Those skilled in the art will understand that the principles of the present disclosure may be implemented in any suitably arranged system or device.

[0028] The following documents and standards descriptions are hereby incorporated by reference into the present disclosure as if fully set forth herein: [1] IEEE P802.11be/D2.0, 2022.

[0029] Embodiments of the present disclosure provide mechanisms for an operation parameter update for EPCS operation.

[0030] FIG. **1** illustrates an example wireless network **100** according to various embodiments of the present disclosure. The embodiment of the wireless network **100** shown in FIG. **1** is for illustration only. Other embodiments of the wireless network **100** could be used without departing from the scope of this disclosure.

[0031] The wireless network **100** includes APs **101** and **103**. 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 STAs **111-114** within a coverage area **120** of the AP **101**. The APs **101-103** may communicate with each other and with the STAs **111-114** using Wi-Fi or other WLAN communication techniques.

[0032] 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 (e.g., an AP 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.). This type of STA may also be referred to as a non-AP STA.

[0033] In various embodiments of this disclosure, each of the APs **101** and **103** and each of the STAs **111-114** may be an MLD. In such embodiments, APs **101** and **103** may be AP MLDs, and STAs **111-114** may be non-AP MLDs. Each MLD is affiliated with more than one STA. For convenience of explanation, an AP MLD is described herein as affiliated with more than one AP (e.g., more than one AP STA), and a non-AP MLD is described herein as affiliated with more than one STA (e.g., more than one non-AP STA).

[0034] Dotted lines show the approximate extents of the coverage areas **120** and **125**, which are shown as approximately circular for the purposes of illustration and explanation only. It should be clearly understood that the coverage areas associated with APs, such as the coverage areas **120** and **125**, may have other shapes, including irregular shapes, depending upon the configuration of the APs and variations in the radio environment associated with natural and man-made obstructions.

[0035] As described in more detail below, one or more of the APs may include circuitry and/or programming for traffic urgency indication. Although FIG. **1** illustrates 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 **101-103** could communicate directly with the network **130** and provide 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.

[0036] FIG. **2**A illustrates an example AP **101** according to various embodiments of the present disclosure. The embodiment of the AP **101** illustrated in FIG. **2**A is for illustration only, and the AP **103** of FIG. **1** could have the same or similar configuration. In the embodiments discussed herein below, the AP **101** is an AP MLD. However, APs come in a wide variety of configurations, and FIG. **2**A does not limit the scope of this disclosure to any particular implementation of an AP.

[0037] The AP MLD **101** is affiliated with multiple APs **202***a*-**202***n* (which may be referred to, for example, as AP1-APn). Each of the affiliated APs **202***a*-**202***n* includes multiple antennas **204***a*-**204***n*, multiple RF transceivers **209***a*-**209***n*, transmit (TX) processing circuitry **214**, and receive (RX) processing circuitry **219**. The AP MLD **101** also includes a controller/processor **224**, a memory **229**, and a backhaul or network interface **234**.

[0038] The illustrated components of each affiliated AP **202***a*-**202***n* may represent a physical (PHY) layer and a lower media access control (LMAC) layer in the open systems interconnection (OSI) networking model. In such embodiments, the illustrated components of the AP MLD **101** represent a single upper MAC (UMAC) layer and other higher layers in the OSI model, which are shared by all of the affiliated APs **202***a*-**202***n*.

[0039] For each affiliated AP **202***a*-**202***n*, 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**. In some embodiments, each affiliated AP **202***a*-**202***n* operates at a different bandwidth, e.g., 2.4 GHz, 5 GHz, or 6 GHz, and accordingly the incoming RF signals received by each affiliated AP may be at a different frequency of RF. The RF transceivers **209***a*-**209***n* down-convert the incoming RF signals to generate 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.

[0040] For each affiliated AP **202***a*-**202***n*, 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-convert the baseband or IF signals to RF signals that are transmitted via the antennas **204***a*-**204***n*. In embodiments wherein each affiliated AP **202***a*-**202***n* operates at a different bandwidth, e.g., 2.4 GHz, 5 GHz, or 6 GHz, the outgoing RF signals transmitted by each affiliated AP may be at a different frequency of RF.

[0041] The controller/processor **224** can include one or more processors or other processing devices that control the overall operation of the AP MLD **101**. For example, the controller/processor **224** could control the reception of forward channel signals and the transmission of reverse channel 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 MLD **101** by the controller/processor **224** including an operation parameter update for EPCS operation. In some embodiments, the controller/processor **224** includes 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.

[0042] The controller/processor **224** is also coupled to the backhaul or network interface **234**. The backhaul or network interface **234** allows the AP MLD **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 MLD **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** includes 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.

[0043] As described in more detail below, the AP MLD **101** may include circuitry and/or programming for an operation parameter update for EPCS operation. Although FIG. **2**A illustrates one example of AP MLD **101**, various changes may be made to FIG. **2**A. For example, the AP MLD **101** could include any number of each component shown in FIG. **2**A. As a particular example, an AP MLD **101** 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 particular example, while each affiliated AP **202***a*-**202***n* is shown as including a single instance of TX processing circuitry **214** and a single instance of RX processing circuitry **219**, the AP MLD **101** could include multiple instances of each (such as one per RF transceiver) in one or more of the affiliated APs **202***a*-**202***n*. Alternatively, only one antenna and RF transceiver path may be included in one or more of the affiliated APs **202***a*-**202***n*, 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.

[0044] FIG. **2**B illustrates an example STA **111** according to various embodiments of this disclosure. The embodiment of the STA **111** illustrated in FIG. **2**B is for illustration only, and the STAs **111**-**115** of FIG. **1** could have the same or similar configuration. In the embodiments discussed herein below, the STA **111** is a non-AP MLD. 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.

[0045] The non-AP MLD **111** is affiliated with multiple STAs **203***a*-**203***n* (which may be referred to, for example, as STA1-STAn). Each of the affiliated STAs **203***a*-**203***n* includes antenna(s) **205**, a radio frequency (RF) transceiver **210**, TX processing circuitry **215**, and receive (RX) processing circuitry **225**. The non-AP MLD **111** also includes a microphone **220**, 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** includes an operating system (OS) **261** and one or more applications **262**.

[0046] The illustrated components of each affiliated STA **203***a*-**203***n* may represent a PHY layer and an LMAC layer in the OSI networking model. In such embodiments, the illustrated components of the non-AP MLD **111** represent a single UMAC layer and other higher layers in the OSI model, which are shared by all of the affiliated STAs **203***a*-**203***n*.

[0047] For each affiliated STA **203***a*-**203***n*, the RF transceiver **210** receives from the antenna(s) **205**, an incoming RF signal transmitted by an AP of the network **100**. In some embodiments, each affiliated STA **203***a*-**203***n* operates at a different bandwidth, e.g., 2.4 GHz, 5 GHz, or 6 GHz, and accordingly the incoming RF signals received by each affiliated STA may be at a different frequency of RF. The RF transceiver **210** down-converts the incoming RF signal to generate an intermediate frequency (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).

[0048] For each affiliated STA **203***a*-**203***n*, 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**. In embodiments wherein each affiliated STA **203***a*-**203***n* operates at a different bandwidth, e.g., 2.4 GHz, 5 GHz, or 6 GHz, the outgoing RF signals transmitted by each affiliated STA may be at a different frequency of RF.

[0049] 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 non-AP MLD **111**. In one such operation, the main controller/processor **240** controls the reception of forward channel signals and the transmission of reverse channel signals by the RF transceiver **210**, the RX processing circuitry **225**, and the TX processing circuitry **215** in accordance with well-known principles. The main controller/processor **240** can also include processing circuitry configured to support an operation parameter update for EPCS operation. In some embodiments, the controller/processor **240** includes at least one microprocessor or microcontroller.

[0050] The controller/processor **240** is also capable of executing other processes and programs resident in the memory **260**, such as operations for supporting an operation parameter update for EPCS operation. 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 supporting operation parameter update for EPCS operation. 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 main controller/processor **240** is also coupled to the I/O interface **245**, which provides non-AP MLD **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 **240**.

[0051] The controller/processor **240** is also coupled to the touchscreen **250** and the display **255**. The operator of the non-AP MLD **111** can use the touchscreen **250** to enter data into the non-AP MLD **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).

[0052] Although FIG. **2**B illustrates one example of non-AP MLD **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, one or more of the affiliated STAs **203***a*-**203***n* may include any number of antenna(s) **205** for MIMO communication with an AP **101**. In another example, the non-AP MLD **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 non-AP MLD **111** configured as a mobile telephone or smartphone, non-AP MLDs can be configured to operate as other types of mobile or stationary devices.

[0053] Emergency telecommunication services have been implemented in a number of countries with the objective of providing prioritized access in the times of disasters or emergencies. Examples of such telecommunication services in the United States include government emergency telecommunication service (GETS), wireless priority service (WPS), next generation network priority services (NGN priority services), telecommunications service priority (TSP), etc. Such services have also been implemented in other countries. Examples of such services include blue light mobile service in Belgium, mobile telecommunications privileged access scheme in Great Britain, disaster priority telephone in Japan, etc. Typically, such services are subscription based, operator controlled, enabled through global standards and are offered over commercial network infrastructure.

[0054] In recent times there has been a growing need for such services over Wi-Fi networks. In IEEE 802.11be, Emergency preparedness communication services (EPCS) has been introduced with the goal of providing prioritized access to certain authorized users. As a part of this service, the user that has associated with an AP can be authorized by the AP to take advantage of EPCS service. Once authorized, the user can use an enhanced EDCA parameter set with values for parameters such as CWmin[AC], CWmax[AC], AIFSN[AC], TXOP[AC], etc. which are different from those for other STAs associated with the same AP. With this enhanced EDCA parameter set, the non-AP MLD that is authorized by the AP, benefits from prioritized access as it can capture the channel faster compared to other users in the network. After EPCS is disabled, the non-AP MLD can update its EDCA parameter set to match that of other non-EPCS users in the network.

[0055] Various embodiments of the present disclosure recognize that after setup of EPCS, when a non-AP MLD is using the EPCS priority access feature, the network and traffic conditions can change. Further, the number of associated non-EPCS devices can also increase. As a result, the originally provided EDCA parameter set to the non-AP MLD may no longer provide it the same level of priority access that it was when EPCS priority access was setup.

[0056] Accordingly, various embodiments of the present disclosure provide mechanisms for enabling an AP MLD/AP to change or update the EPCS operation parameters for EPCS devices in the network.

[0057] FIG. **3** illustrates an example scenario **300** involving EPCS authorized devices co-existing with non-EPCS devices according to embodiments of the present disclosure. The embodiment of the example scenario **300** involving EPCS authorized devices co-existing with non-EPCS devices shown in FIG. **3** is for illustration only. Other embodiments of the example scenario **300** involving EPCS authorized devices co-existing with non-EPCS devices could be used without departing from the scope of this disclosure.

[0058] Consider a scenario as depicted in FIG. **3**. An AP MLD with affiliated APs-AP 1 and AP 2 has multiple non-AP MLDs associated with it. The non-AP MLDs are denoted as non-AP MLD1, non-AP MLD2 and non-AP MLD3. Non-AP MLD1 is EPCS authorized and has EPCS priority access enabled. Further, as per the EPCS priority access setup procedure in the IEEE P802.11 specification, non-AP MLD1 has been provided with an enhanced EDCA parameter set by AP MLD1 during the setup process. This enhanced EDCA parameter set provides EPCS authorized non-AP MLD1 a higher priority over other non-EPCS devices in the network (by providing it a higher probability of acquiring channel during channel access).

[0059] After setup of EPCS when non-AP MLD1 is using the EPCS priority access feature, the network and traffic conditions can change. Further, the number of associated non-EPCS devices can also increase. As a result, the originally provided EDCA parameter set to non-AP MLD1 may no longer provide it the same level of priority access that it was when EPCS priority access was setup. Consequently, the AP MLD may want to change the EPCS operation parameters for EPCS authorized devices.

[0060] As used in the present disclosure, the term device can be interpreted as referring to a non-AP MLD or a non-AP STA (when there is no MLO operation). It can also refer to non-AP STAs affiliated with a non-AP MLD.

[0061] FIG. **4** illustrates an example method **400** for explicit teardown and re-setup for EPCS operation according to embodiments of the present disclosure. The embodiment of the example method **400** for explicit teardown and re-setup for EPCS operation shown in FIG. **4** is for illustration only. Other embodiments of the example method **400** for explicit teardown and re-setup for EPCS operation could be used without departing from the scope of this disclosure.

[0062] As illustrated in FIG. **4**, the method **400** begins at step **402**, where a determination is made whether EPCS operation parameters need an update. If the EPCS operation parameters do not need an update, then at step **404**, no action is needed. If the EPCS operation parameters need an update, then at step **406**, the current EPCS connection is torn down. The teardown can be done by either the AP MLD/AP or by the device. At step **408**, either the AP MLD/AP or the device can re-setup the EPCS connection and obtain an updated parameter set.

[0063] In one embodiment, when the AP MLD detects that the EPCS operation parameters (e.g., enhanced EDCA parameter set for EPCS priority access) provided to EPCS authorized devices no longer provide them with the same level of priority access that they used to after EPCS was setup, the AP can send a frame to tear down the EPCS priority access for the EPCS devices associated with it (e.g., EPCS priority access teardown frame). The teardown frame can contain a reason code to inform the EPCS device that the reason for teardown is because the originally provided EPCS operation parameters need to be updated. After this step,

either the AP MLD or the EPCS device can re-setup EPCS priority access and acquire the new updated EPCS operation parameters.

[0064] In another embodiment, when the non-AP MLD detects that the EPCS operation parameters are providing it with the same level of priority access that they used to after EPCS was setup, the EPCS device can send a frame to tear down the EPCS priority access with a reason code to inform the AP MLD that the reason for teardown is because the originally provided EPCS operation parameters need to be updated. This tear down and re-setup operations can be performed on any of the links setup between the AP MLD and the EPCS device.

[0065] According to another embodiment, AP MLD can maintain updated EPCS operation parameters. Thus, whenever a non-AP MLD tears down and performs re-setup, it can obtain updated EPCS operation parameters.

[0066] FIG. **5** illustrates an example method **500** performed by an AP for implicit teardown and EPCS re-setup according to embodiments of the present disclosure. The embodiment of the example method **500** performed by an AP for implicit teardown and EPCS re-setup shown in FIG. **5** is for illustration only. Other embodiments of the example method **500** performed by an AP for implicit teardown and EPCS re-setup could be used without departing from the scope of this disclosure.

[0067] As illustrated in FIG. **5**, the method **500** begins at step **502**, where a determination is made whether EPCS operation parameters need an update. If the EPCS operation parameters do not need an update, then at step **504**, no action is needed. If the EPCS operation parameters need an update, then at step **506**, the AP MLD/AP stops to advertise EPCS capability in management frames. At step **508**, a determination is made whether teardown is complete for all EPCS devices. If teardown is not complete for all EPCS devices, then at step **510**, the method waits for teardown completion. If teardown is complete for all EPCS devices, then at step **512**, the AP MLD/AP starts to advertise EPCS capability in management frames.

[0068] In one embodiment, the AP MLD can stop advertising its EPCS capability in management frames (e.g., beacon and probe response frames). Upon receiving a management frame that no longer shows the EPCS capability indication for the AP and if this management frame was previously showing the capability, then the EPCS devices associated with the AP can set their EPCS state to torn down within a time duration (e.g., within the beacon interval) as shown in FIG. **5**.

[0069] FIG. **6** illustrates an example method **600** performed by an STA for implicit teardown and EPCS re-setup according to embodiments of the present disclosure. The embodiment of the example method **600** performed by an STA for implicit teardown and EPCS re-setup shown in FIG. **6** is for illustration only. Other embodiments of the example method **600** performed by an STA for implicit teardown and EPCS re-setup could be used without departing from the scope of this disclosure.

[0070] As illustrated in FIG. **6**, the method **600** begins at step **602**, where a determination is made whether a device receives a management frame from the AP MLD/AP that no longer indicates EPCS capability. If the device does not receive a management frame from the AP MLD/AP that no longer indicates EPCS capability, then at step **604**, no action is needed. If the device receives a management frame from the AP MLD/AP that no longer indicates EPCS capability, then at step **606**, the device can re-setup the EPCS connection.

[0071] The AP MLD can again start to advertise its EPCS capability in management frames. If an EPCS capable device receives a management frame that now shows the capability with the associated AP MLD, it can re-setup its EPCS connection with the AP MLD as shown in FIG. **6**. During this re-setup, AP MLD can provide the updated EPCS operation parameters (e.g., the enhanced EDCA parameter set) to the device upon authorization.

[0072] FIG. **7** illustrates an example method **700** performed by an AP for transmission of an unsolicited update frame according to embodiments of the present disclosure. The embodiment of the example method **700** performed by an AP for transmission of an unsolicited update frame shown in FIG. **7** is for illustration only. Other embodiments of the example method **700** performed by an AP for transmission of an unsolicited update frame could be used without departing from the scope of this disclosure.

[0073] As illustrated in FIG. **7**, the method **700** begins at step **702**, where a determination is made whether EPCS operation parameters need an update. If the EPCS operation parameters do not need an update, then at step **704**, no action is needed. If the EPCS operation parameters need an update, then at step **706**, the AP transmits an unsolicited update frame to EPCS devices.

[0074] FIG. **8** illustrates an example method **800** performed by an STA for transmission of an unsolicited update frame according to embodiments of the present disclosure. The embodiment of the example method **800** performed by an STA for transmission of an unsolicited update frame shown in FIG. **8** is for illustration only. Other embodiments of the example method **800** performed by an STA for transmission of an unsolicited update frame could be used without departing from the scope of this disclosure.

[0075] As illustrated in FIG. **8**, the method **800** begins at step **802**, where a determination is made whether a device receives an unsolicited update frame. If the device does not receive an unsolicited update frame, then at step **804**, no action is needed. If the device receives an unsolicited update frame, then at step **806**, the device updates EPCS operation parameters.

[0076] In one embodiment, an AP MLD can send an unsolicited frame to the EPCS devices and provide them with updated EPCS operation parameters (e.g., enhanced EDCA parameter set for EPCS priority access). Another example can be the MU EDCA parameters.

[0077] According to one embodiment, the unsolicited frame can contain one or more of the information fields indicated in Table 1.

TABLE 1

Information fields present in the unsolicited frame transmitted by the AP MLD to the EPCS associated devices for updating EPCS operation parameters

Information field	Description
Reason code	A reason code stating the reason for sending the frame (e.g., EPCS operation parameter update).
Category	Action field category definition (e.g., EHT)
Protected EHT Action	Defining the type of action that is being requested (e.g., EPCS priority access enable request)
Dialog Token	A token for matching the action responses with the action requests.
Updated EPCS operation parameters	Updated EPCS operation parameters (e.g., EDCA parameter set). This field can also contain EPCS operation parameters for each of the link setup between the AP and the EPCS authorized device.
Priority access multi-link element	A priority access multi-link element that carries the updated EPCS operation parameters (e.g., EDCA parameter set, MU EDCA parameters set).

[0078] The above information can also be transmitted by the AP in any of the frames defined in the standard (e.g., the EPCS priority access enable request frame, the EPCS priority access enable response frame, etc.).

[0079] Upon receiving the above frame from the AP, the EPCS device can update the EPCS operation parameters and continue its operation with these updated parameters. Specifically, the EPCS device (e.g., each non-AP STA affiliated with an EPCS non-AP MLD) can update its dot11EDCATable to the values indicated in the frame transmitted by the AP MLD/AP corresponding to its own link as indicated, for instance, by a link ID. The EPCS device (e.g., each non-AP STA affiliated with an EPCS non-AP MLD) can update its dot11MUEDCATable to the values indicated in the frame transmitted by the AP MLD/AP corresponding to its own link as indicated, for instance, by a link ID. The update can either be done immediately or as soon as possible/practical in implementation.

[0080] According to one embodiment, the frame can carry a priority access multi-link element with a per-STA profile with an EDCA Parameters Set element containing the updated EDCA and MU EDCA parameters for each set up link.

[0081] The above frame can be transmitted in a unicast, group cast or broadcast manner. When the update is done in a broadcast manner, the frame transmitted by the AP MLD/AP to the EPCS enabled non-AP MLDs can be called a broadcast EPCS Priority Access Enable Request frame (and similarly broadcast EPCS Priority Access enable response frame, broadcast EPCS Priority Access Teardown frame, etc.) and can contain updated EDCA parameters in the Priority Access Multi-link element. Further, according to this embodiment, when the AP MLD/AP transmits broadcast EPCS Priority Access Enable Request frame, it can set the PeerSTAAddress to the broadcast address.

[0082] In another embodiment, the AP can transmit one or more of the information fields shown in Table 2, in any of the management frames (e.g., Beacon frame). Thus, when the AP detects a need for updating the EPCS operation parameters, it can do so and then send the updated EPCS operation parameters in the management frames.

TABLE 2

Information transmitted in management frames for EPCS operation

Information field	Description
Normal operation parameter set	Parameter set (e.g., EDCA parameter set) that is used by normal devices. In one embodiment this parameter set can be provided on a per link basis. Thus, each link can have a normal operation parameter set.
Normal operation parameter set indicator	Indication that the parameter set indicated by the above field is for normal operation. E.g., this can be done by using a bit that is set to a particular value (e.g., 1) to indicate that the parameter set is the normal operation parameter set.
EPCS operation parameter set	Parameter set (e.g., enhanced EDCA parameter set) that is used by EPCS authorized devices. In one embodiment this parameter set can be provided on a per link basis. Thus, each link can have a EPCS operation parameter set.
EPCS operation parameter set indicator	Indication that the parameter set indicated by the above field is for EPCS operation. E.g., this can be done by using a bit that is set to a particular value (e.g., 1) to indicate that the parameter set is the EPCS operation parameter set.
Update time	The time after which the update needs to be applied by the EPCS devices.

[0083] FIG. **9** illustrates an example method **900** for a management frame based EPCS operation parameter update according to embodiments of the present disclosure. The embodiment of the example method **900** for a management frame based EPCS operation parameter update shown in

FIG. **9** is for illustration only. Other embodiments of the example method **900** for a management frame based EPCS operation parameter update could be used without departing from the scope of this disclosure.

[0084] As illustrated in FIG. **9**, the method **900** begins at step **902**, where a determination is made whether a device receives a management frame. If the device does not receive a management frame, then at step **904**, no action is necessary. If the device receives a management frame, then at step **906**, a check for an EPCS parameter set is performed. At step **908**, a determination is made whether the parameter set matches a current operation parameter set. If the parameter set matches a current operation parameter set, then at step **910**, no action is needed. If the parameter set does not match the current operation parameter set, then at step **912**, the EPCS operation parameter set is updated.

[0085] When an EPCS device receives a management frame with an EPCS operation parameter set that does not match the one it is currently using, the EPCS device can update the EPCS operation parameter set and can start to use the new one. In one embodiment, this update can be instantaneous after receiving the frame. In another embodiment, the AP MLD can provide the time after which the update needs to be applied. Thus, the EPCS device can apply the update after the specified time.

[0086] FIG. **10** illustrates an example method **1000** performed by an AP for degrading a normal operation parameter set according to embodiments of the present disclosure. The embodiment of the example method **1000** performed by an AP for degrading a normal operation parameter set shown in FIG. **10** is for illustration only. Other embodiments of the example method **1000** performed by an AP for degrading a normal operation parameter set could be used without departing from the scope of this disclosure.

[0087] As illustrated in FIG. **10**, the method **1000** begins at step **1002**, where a determination is made whether an EPCS operation parameter needs an update. If the EPCS operation parameter does not need an update, then at step **1004**, no action is needed. If the EPCS operation parameter needs an update, then at step **1006**, normal operation parameters advertised in management frames are degraded.

[0088] In one embodiment, the AP MLD can advertise the normal operation parameter set (e.g., EDCA parameter set) in management frames (e.g., beacons). Further, according to this embodiment, when the AP detects that the assigned EPCS parameter set does not meet the priority requirements that it was originally intended to, the AP can modify the normal operation parameter set in a manner that the EPCS parameter set will continue to provide the same/similar level of priority that it was originally providing. Thus, the STAs with EPCS priority access enabled can obtain higher priority over those that do not have EPCS priority access enabled. For instance, the AP can degrade the EDCA parameter set for normal operation parameter. The AP can advertise this new normal operation parameter set in management frames and non-EPCS devices can use this new parameter set as depicted in FIG. **10**. Thus, EPCS devices can continue to maintain their priority level. After some time (e.g., network/traffic conditions change again), when the AP determines that the original normal operation parameter set can be used again, it can transmit the original operation parameter set to the non-EPCS devices.

[0089] In one embodiment, the AP MLD can maintain the performance of EPCS devices by only degrading and upgrading the normal operation parameter set for non-EPCS devices.

[0090] In another embodiment, the AP MLD can use this degradation as a temporary solution to keep the performance while the AP upgrades the EPCS operation parameters of the EPCS authorized devices. According to this embodiment, once the AP degrades the performance of other devices, it can tear down and re-setup the EPCS connection for each EPCS device (as indicated in "1. Teardown and re-setup the connection", "2. Implicit teardown and EPCS re-setup" or update the EPCS operation parameter set (as indicated in "3. Unsolicited update frame"). Thus, the EPCS operation parameters of each EPCS device can get updated. Following this update, the AP MLD can again reset the normal operation parameter set in management frames and non-EPCS devices can use that set again.

[0091] In one embodiment, the AP can broadcast a frame containing one or more of the information fields indicated in Table 3 below.

TABLE 3

Information transmitted broadcast teardown notification frame

Information field	Description
Reason code	A reason code stating the reason for sending the frame (e.g., EPCS operation parameter update).
Category	Action field category definition (e.g., EHT)
Protected EHT Action	Defining the type of action that is being requested (e.g., EPCS priority access teardown)
Dialog Token	A token for matching the action responses with the action requests.

[0092] Upon receiving the above frame, either the EPCS devices can re-setup their EPCS priority access again and thus receive an updated EPCS operation parameter set or the AP can send an unsolicited frame resetting up the EPCS connection for the EPCS devices (e.g., an unsolicited EPCS priority access enable request frame or response frame).

[0093] The above update can also be performed in a unicast, group cast or broadcast manner.

[0094] In one embodiment, the AP MLD can transmit a broadcast action frame with updated EPCS operation parameters (e.g., EDCA parameter set) on each of the links that are setup between the EPCS device and the AP MLD. Upon receiving the broadcast action frame, each EPCS device can update their EPCS operation parameters.

[0095] Instead of providing one EPCS operation parameter set (e.g., EDCA parameter set), the AP MLD can provide multiple EPCS operation parameter set to a device during EPCS authorization procedure. Further, according to this embodiment, the AP can advertise which EPCS operation parameter set that it currently uses in frames that it transmits to the EPCS devices or in broadcast frames (e.g., management frames). Thus, the EPCS authorized devices can update the EPCS operation parameter set based on this indication.

[0096] For any of the above procedures, the update can be done in a unicast, group cast or broadcast manner.

[0097] The above embodiments can also be used when the AP and/or the associated EPCS device are not MLDs.

[0098] Further, the information indicated in the above embodiments can either be provided on a device level or on a link level.

[0099] Further, the information indicated in the above embodiments can be transmitted in any of the existing frames in the specification.

[0100] The EPCS operation parameters set can either be EDCA parameters set or the MU EDCA parameters set.

[0101] The above embodiments can also apply to non-EPCS features such as R-TWT for providing priority access to other types of traffic. For example, latency sensitive or low latency traffic.

[0102] FIG. **11** illustrates a flowchart of a method **1100** for wireless communication performed by an AP-MLD that includes APs. The embodiment of the method **1100** for wireless communication performed by an AP-MLD shown in FIG. **11** is for illustration only. Other embodiments of the method **1100** for wireless communication performed by an AP-MLD could be used without departing from the scope of this disclosure.

[0103] As illustrated in FIG. **11**, the method **1100** begins at step **1102**, where the non-AP MLD forms a link with a corresponding STA of a non-AP MLD. At step **1104**, the non-AP MLD transmits information associated with EPCS operation parameters to the corresponding STA. At step **1106**, the non-AP MLD determines whether the EPCS operation parameters transmitted to the corresponding STA need to be updated. At step **1108**, when the EPCS operation parameters transmitted to the corresponding STA do not need to be updated, the non-AP MLD continues with current EPCS operation parameters. At step **1110**, when the EPCS operation parameters transmitted to the corresponding STA need to be updated, the non-AP MLD determines a procedure for updating the EPCS operation parameters.

[0104] In one embodiment, the EPCS operation parameters transmitted to the corresponding STA need to be updated, and the non-AP MLD generates a teardown message for tearing down the EPCS operation parameters for the corresponding STA, determines that the EPCS operation parameters have been torn down, and sets up updated EPCS operation parameters with the corresponding STA.

[0105] In one embodiment, the EPCS operation parameters transmitted to the corresponding STA need to be updated, and the non-AP MLD receives a teardown message from the corresponding STA for tearing down the EPCS operation parameters for the corresponding STA, determines that the EPCS operation parameters have been torn down, and sets up updated EPCS operation parameters with the corresponding STA.

[0106] In one embodiment, the EPCS operation parameters transmitted to the corresponding STA need to be updated, and the non-AP MLD generates a first management frame indicating that the AP MLD no longer has EPCS capability, determines that the EPCS operation parameters have been torn down, generates a second management frame indicating that the AP MLD again has EPCS capability, and sets up updated EPCS operation parameters with the corresponding STA.

[0107] In one embodiment, the EPCS operation parameters transmitted to the corresponding STA need to be updated, and the non-AP MLD generates a message for updating the EPCS operation parameters of the corresponding STA, and transmits, unsolicited, the message for updating the EPCS operation parameters.

[0108] In one embodiment, the message for updating the EPCS operation parameters comprises a frame that includes an action field.

[0109] In one embodiment, the message for updating the EPCS operation parameters comprises a frame that includes a priority access multi-link element.

[0110] In one embodiment, the message for updating the EPCS operation parameters comprises an EPCS priority access enable response frame that includes updated values of the EPCS operation parameters.

[0111] In one embodiment, the EPCS operation parameters transmitted to the corresponding STA need to be updated, and the non-AP MLD generates a management frame for setting up updated EPCS operation parameters with the corresponding STA, and sets up the updated EPCS operation parameters with the corresponding STA.

[0112] In one embodiment, the EPCS operation parameters transmitted to the corresponding STA need to be updated, and the non-AP MLD generates an action frame for setting up updated EPCS operation parameters with the corresponding STA, and sets up the updated EPCS operation parameters with the corresponding STA.

[0113] In one embodiment, the EPCS operation parameters transmitted to the corresponding STA need to be updated, and the non-AP MLD generates multiple sets of EPCS operation parameters for the corresponding STA, generates a message indicating which of the multiple sets of EPCS operation parameters is currently in use, and based on the message indicating which of the multiple sets of EPCS operation parameters is currently in use, sets up updated EPCS operation parameters with the corresponding STA.

[0114] The above flowcharts illustrate example methods that can be implemented in accordance with the principles of the present disclosure and various changes could be made to the methods or processes illustrated in the flowcharts. For example, while shown as a series of steps, various steps could overlap, occur in parallel, occur in a different order, or occur multiple times. In another example, steps may be omitted or replaced by other steps.

[0115] Although the present disclosure has been described with an exemplary embodiment, various changes and modifications may be suggested to one skilled in the art. It is intended that the present disclosure encompass such changes and modifications as fall within the scope of the appended claims. None of the description in this application should be read as implying that any particular element, step, or function is an essential element that must be included in the claims scope. The scope of patented subject matter is defined by the claims.

What is claimed is:

1. An access point (AP) multi-link device (MLD) comprising:

APs, each comprising a transceiver configured to:

form a link with a corresponding station (STA) of a non-AP MLD; and

transmit information associated with emergency preparedness communication services (EPCS) operation parameters to the corresponding STA; and

a processor operably coupled to the transceiver, the processor configured to:

determine whether the EPCS operation parameters transmitted to the corresponding STA need to be updated;

when the EPCS operation parameters transmitted to the corresponding STA do not need to be updated, continue with current EPCS operation parameters; and

when the EPCS operation parameters transmitted to the corresponding STA need to be updated, determine a procedure for updating the EPCS operation parameters.

2. The AP MLD device of claim **1**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

generate a teardown message for tearing down the EPCS operation parameters for the corresponding STA,

determine that the EPCS operation parameters have been torn down, and

setup updated EPCS operation parameters with the corresponding STA.

3. The AP MLD device of claim **1**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated,

the transceiver is configured to receive a teardown message from the corresponding STA for tearing down the EPCS operation parameters for the corresponding STA, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

determine that the EPCS operation parameters have been torn down, and

setup updated EPCS operation parameters with the corresponding STA.

4. The AP MLD device of claim **1**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

generate a first management frame indicating that the AP MLD no longer has EPCS capability,

determine that the EPCS operation parameters have been torn down,

generate a second management frame indicating that the AP MLD again has EPCS capability, and

setup updated EPCS operation parameters with the corresponding STA.

5. The AP MLD device of claim **1**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated,

to determine the procedure for updating the EPCS operation parameters, the processor is configured to generate a message for updating the EPCS operation parameters of the corresponding STA, and

the transceiver is configured to transmit, unsolicited, the message for updating the EPCS operation parameters.

6. The AP MLD device of claim **5**, wherein the message for updating the EPCS operation parameters comprises a frame that includes an action field.

7. The AP MLD device of claim **5**, wherein the message for updating the EPCS operation parameters comprises a frame that includes a priority access multi-link element.

8. The AP MLD device of claim **5**, wherein the message for updating the EPCS operation parameters comprises an EPCS priority access enable response frame that includes updated values of the EPCS operation parameters.

9. The AP MLD device of claim **1**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

generate a management frame for setting up updated EPCS operation parameters with the corresponding STA, and

setup the updated EPCS operation parameters with the corresponding STA.

10. The AP MLD device of claim **1**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

generate an action frame for setting up updated EPCS operation parameters with the corresponding STA, and

setup the updated EPCS operation parameters with the corresponding STA.

11. The AP MLD device of claim **1**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

generate multiple sets of EPCS operation parameters for the corresponding STA,

generate a message indicating which of the multiple sets of EPCS operation parameters is currently in use; and

based on the message indicating which of the multiple sets of EPCS operation parameters is currently in use, setup updated EPCS operation parameters with the corresponding STA.

12. A non-access point (AP) multi-link device (MLD) comprising:

stations (STAs), each comprising a transceiver configured to:

form a link with a corresponding AP of an AP MLD; and

receive information associated with emergency preparedness communication services (EPCS) operation parameters from the corresponding AP; and

a processor operably coupled to the transceiver, the processor configured to:

determine whether the EPCS operation parameters received from the corresponding AP need to be updated;

when the EPCS operation parameters received from the corresponding AP do not need to be updated, continue with current EPCS operation parameters; and

when the EPCS operation parameters received from the corresponding AP need to be updated, determine a procedure for updating the EPCS operation parameters.

13. The non-AP MLD device of claim **12**, wherein:

the EPCS operation parameters received from the corresponding AP need to be updated,

the transceiver is configured to receive a teardown message for tearing down the EPCS operation parameters for the corresponding AP, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

determine that the EPCS operation parameters have been torn down, and

setup updated EPCS operation parameters with the corresponding AP.

14. The non-AP MLD device of claim **12**, wherein:

the EPCS operation parameters received from the corresponding AP need to be updated,

the transceiver is configured to transmit a teardown message to the corresponding AP for tearing down the EPCS operation parameters for the corresponding AP, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

determine that the EPCS operation parameters have been torn down, and

setup updated EPCS operation parameters with the corresponding AP.

15. The non-AP MLD device of claim **12**, wherein:

the EPCS operation parameters received from the corresponding AP need to be updated,

the transceiver is configured to:

receive a first management frame indicating that the AP MLD no longer has EPCS capability,

receive a second management frame indicating that the AP MLD again has EPCS capability, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured to:

determine that the EPCS operation parameters have been torn down, and

setup updated EPCS operation parameters with the corresponding AP.

16. The non-AP MLD device of claim **12**, wherein:

the EPCS operation parameters received from the corresponding AP need to be updated,

the transceiver is configured to receive an unsolicited message for updating the EPCS operation parameters, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured, based on the received unsolicited message, to update the EPCS operation parameters.

17. The non-AP MLD device of claim **16**, wherein the message for updating the EPCS operation parameters comprises a frame that includes an action field.

18. The non-AP MLD device of claim **16**, wherein the message for updating the EPCS operation parameters comprises a frame that includes a priority access multi-link element.

19. The non-AP MLD device of claim **16**, wherein the message for updating the EPCS operation parameters comprises an EPCS priority access enable response frame that includes updated values of the EPCS operation parameters.

20. The non-AP MLD device of claim **12**, wherein:

the EPCS operation parameters received from the corresponding AP need to be updated,

the transceiver is configured to receive a management frame for setting up updated EPCS operation parameters with the corresponding AP, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured, based on the received management frame, to setup the updated EPCS operation parameters with the corresponding AP.

21. The non-AP MLD device of claim **12**, wherein:

the EPCS operation parameters received from the corresponding AP need to be updated,

the transceiver is configured to receive an action frame for setting up updated EPCS operation parameters with the corresponding AP, and

to determine the procedure for updating the EPCS operation parameters, the processor is configured, based on the received action frame, to setup the updated EPCS operation parameters with the corresponding AP.

22. The non-AP MLD device of claim **12**, wherein:

the EPCS operation parameters received from the corresponding AP need to be updated,

the transceiver is configured to:

receive multiple sets of EPCS operation parameters for the corresponding AP,

receive a message indicating which of the multiple sets of EPCS operation parameters is currently in use; and

to determine the procedure for updating the EPCS operation parameters, the processor is configured, based on the message indicating which of the multiple sets of EPCS operation parameters is currently in use, to setup updated EPCS operation parameters with the corresponding AP.

23. A method for wireless communication performed by an access point (AP) multi-link device (MLD) that includes APs, the method comprising:

forming a link with a corresponding station (STA) of a non-AP MLD;

transmitting information associated with emergency preparedness communication services (EPCS) operation parameters to the corresponding STA;

determining whether the EPCS operation parameters transmitted to the corresponding STA need to be updated;

when the EPCS operation parameters transmitted to the corresponding STA do not need to be updated, continuing with current EPCS operation parameters; and

when the EPCS operation parameters transmitted to the corresponding STA need to be updated, determining a procedure for updating the EPCS operation parameters.

24. The method of claim **23**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated, and

the method further comprises:

generating a teardown message for tearing down the EPCS operation parameters for the corresponding STA,

determining that the EPCS operation parameters have been torn down, and

setting up updated EPCS operation parameters with the corresponding STA.

25. The method of claim **23**, wherein:

the EPCS operation parameters transmitted to the corresponding STA need to be updated, and

the method further comprises:

receiving a teardown message from the corresponding STA for tearing down the EPCS operation parameters for the corresponding STA,

determining that the EPCS operation parameters have been torn down, and

setting up updated EPCS operation parameters with the corresponding STA.

26. The method of claim **23**, wherein:
the EPCS operation parameters transmitted to the corresponding STA need to be updated, and
the method further comprises;
generating a message for updating the EPCS operation parameters of the corresponding STA, and
transmitting, unsolicited, the message for updating the EPCS operation parameters.

27. The method of claim **26**, wherein the message for updating the EPCS operation parameters comprises a frame that includes an action field.

28. The method of claim **26**, wherein the message for updating the EPCS operation parameters comprises a frame that includes a priority access multi-link element.

29. The method of claim **26**, wherein the message for updating the EPCS operation parameters comprises an EPCS priority access enable response frame that includes updated values of the EPCS operation parameters.

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