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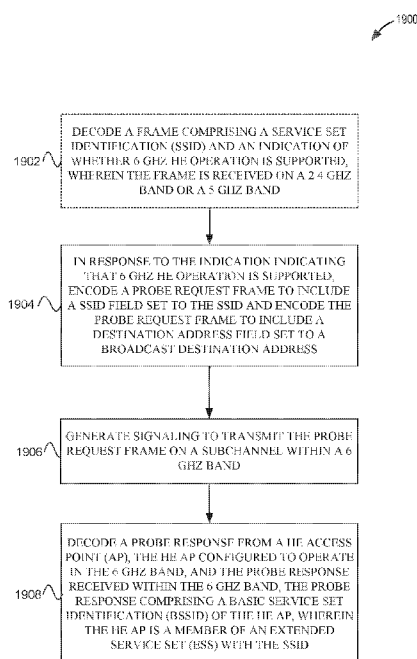


FIG. 19

(57) Abstract: Methods, computer readable media, and apparatus for 6 GHz neighbor reports and capability and operation elements are disclosed. An apparatus is disclosed, the apparatus comprising processing circuitry configured to encode a probe request frame to include a service set identification (SSID) field with a value of the SSID field set to a known SSID and a destination address field with a value of a broadcast destination address. The processing circuitry may be further configured to generate signaling to transmit the probe request frame on a subchannel within a 6 GHz band, and decode a probe response from a 6 GHz HE access point (AP), the probe response received within a 6 GHz band, the probe response comprising a basic service set identification (BSSID) of a 6 GHz HE access point (AP), where the 6 GHz HE AP is a member of an extended service set (ESS) with the known SSID.



6 GHZ NEIGHBOR REPORTS AND CAPABILITY AND OPERATION ELEMENTS

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PRIORITY CLAIM

[0001] This application claims the benefit of priority to United States
10 Provisional Patent Application Serial No. 62/519,301, filed June 14, 2017, which
is incorporated herein by reference in its entirety.

TECHNICAL FIELD

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[0002] Embodiments pertain to wireless networks and wireless
communications. Some embodiments relate to wireless local area networks
(WLANs) and Wi-Fi networks including networks operating in accordance with
the IEEE 802.11 family of standards. Some embodiments relate to IEEE
20 802.11ax and/or IEEE 802.11 next generation. Some embodiments relate to
methods, computer readable media, and apparatus for 6 GHz neighbor reports
and capability and operation elements.

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BACKGROUND

[0003] Efficient use of the resources of a wireless local-area network
(WLAN) is important to provide bandwidth and acceptable response times to the
users of the WLAN. However, often there are many devices trying to share the
30 same resources and some devices may be limited by the communication protocol
they use or by their hardware bandwidth. Moreover, wireless devices may need
to operate with both newer protocols and with legacy device protocols.

BRIEF DESCRIPTION OF THE DRAWINGS

- 5 [0004] The present disclosure is illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:
- [0005] FIG. 1 is a block diagram of a radio architecture in accordance with some embodiments;
- 10 [0006] FIG. 2 illustrates a front-end module circuitry for use in the radio architecture of FIG. 1 in accordance with some embodiments;
- [0007] FIG. 3 illustrates a radio IC circuitry for use in the radio architecture of FIG. 1 in accordance with some embodiments;
- [0008] FIG. 4 illustrates a baseband processing circuitry for use in the radio architecture of FIG. 1 in accordance with some embodiments;
- 15 [0009] FIG. 5 illustrates a WLAN in accordance with some embodiments;
- [0010] FIG. 6 illustrates a block diagram of an example machine upon which any one or more of the techniques (e.g., methodologies) discussed herein may perform;
- 20 [0011] FIG. 7 illustrates a block diagram of an example wireless device upon which any one or more of the techniques (e.g., methodologies or operations) discussed herein may perform;
- [0012] FIG. 8 illustrates a wireless network in accordance with some embodiments;
- 25 [0013] FIG. 9 illustrates a method of 6 GHz association in accordance with some embodiments;
- [0014] FIG. 10 illustrates a method of 6 GHz association in accordance with some embodiments;
- 30 [0015] FIG. 11 illustrates a neighbor report element in accordance with some embodiments;

- [0016] FIG. 12 illustrates basic service set (BSS) identification (ID) information field in accordance with some embodiments;
- [0017] FIG. 13 illustrates a reduced neighbor report element in accordance with some embodiments;
- 5 [0018] FIG. 14 illustrates a neighbor AP information field format in accordance with some embodiments;
- [0019] FIG. 15 illustrates a target beacon transmit time (TBTT) information header subfield in accordance with some embodiments;
- [0020] FIG. 16 illustrates a TBTT information field in accordance with
10 some embodiments;
- [0021] FIG. 17 illustrates a TBTT information field in accordance with some embodiments;
- [0022] FIG. 18 illustrates 6 GHz operation fields in accordance with some embodiments;
- 15 [0023] FIG. 19 illustrates a method of 6 GHz association in accordance with some embodiments; and
- [0024] FIG. 20 illustrates a method of 6 GHz association in accordance with some embodiments.

20 DESCRIPTION

[0025] The following description and the drawings sufficiently illustrate specific embodiments to enable those skilled in the art to practice them. Other embodiments may incorporate structural, logical, electrical, process, and other
25 changes. Portions and features of some embodiments may be included in, or substituted for, those of other embodiments. Embodiments set forth in the claims encompass all available equivalents of those claims.

[0026] FIG. 1 is a block diagram of a radio architecture 100 in accordance with some embodiments. Radio architecture 100 may include radio
30 front-end module (FEM) circuitry 104, radio IC circuitry 106 and baseband processing circuitry 108. Radio architecture 100 as shown includes both

Wireless Local Area Network (WLAN) functionality and Bluetooth (BT) functionality although embodiments are not so limited. In this disclosure, “WLAN” and “Wi-Fi” are used interchangeably.

[0027] FEM circuitry 104 may include a WLAN or Wi-Fi FEM circuitry 104A and a Bluetooth (BT) FEM circuitry 104B. The WLAN FEM circuitry 104A may include a receive signal path comprising circuitry configured to operate on WLAN RF signals received from one or more antennas 101, to amplify the received signals and to provide the amplified versions of the received signals to the WLAN radio IC circuitry 106A for further processing. The BT FEM circuitry 104B may include a receive signal path which may include circuitry configured to operate on BT RF signals received from one or more antennas 101, to amplify the received signals and to provide the amplified versions of the received signals to the BT radio IC circuitry 106B for further processing. FEM circuitry 104A may also include a transmit signal path which may include circuitry configured to amplify WLAN signals provided by the radio IC circuitry 106A for wireless transmission by one or more of the antennas 101. In addition, FEM circuitry 104B may also include a transmit signal path which may include circuitry configured to amplify BT signals provided by the radio IC circuitry 106B for wireless transmission by the one or more antennas. In the embodiment of FIG. 1, although FEM 104A and FEM 104B are shown as being distinct from one another, embodiments are not so limited, and include within their scope the use of an FEM (not shown) that includes a transmit path and/or a receive path for both WLAN and BT signals, or the use of one or more FEM circuitries where at least some of the FEM circuitries share transmit and/or receive signal paths for both WLAN and BT signals.

[0028] Radio IC circuitry 106 as shown may include WLAN radio IC circuitry 106A and BT radio IC circuitry 106B. The WLAN radio IC circuitry 106A may include a receive signal path which may include circuitry to down-convert WLAN RF signals received from the FEM circuitry 104A and provide baseband signals to WLAN baseband processing circuitry 108A. BT radio IC circuitry 106B may in turn include a receive signal path which may include

circuitry to down-convert BT RF signals received from the FEM circuitry 104B and provide baseband signals to BT baseband processing circuitry 108B. WLAN radio IC circuitry 106A may also include a transmit signal path which may include circuitry to up-convert WLAN baseband signals provided by the

5 WLAN baseband processing circuitry 108A and provide WLAN RF output signals to the FEM circuitry 104A for subsequent wireless transmission by the one or more antennas 101. BT radio IC circuitry 106B may also include a transmit signal path which may include circuitry to up-convert BT baseband signals provided by the BT baseband processing circuitry 108B and provide BT

10 RF output signals to the FEM circuitry 104B for subsequent wireless transmission by the one or more antennas 101. In the embodiment of FIG. 1, although radio IC circuitries 106A and 106B are shown as being distinct from one another, embodiments are not so limited, and include within their scope the use of a radio IC circuitry (not shown) that includes a transmit signal path and/or

15 a receive signal path for both WLAN and BT signals, or the use of one or more radio IC circuitries where at least some of the radio IC circuitries share transmit and/or receive signal paths for both WLAN and BT signals.

[0029] Baseband processing circuitry 108 may include a WLAN baseband processing circuitry 108A and a BT baseband processing circuitry

20 108B. The WLAN baseband processing circuitry 108A may include a memory, such as, for example, a set of RAM arrays in a Fast Fourier Transform or Inverse Fast Fourier Transform block (not shown) of the WLAN baseband processing circuitry 108A. Each of the WLAN baseband circuitry 108A and the BT baseband circuitry 108B may further include one or more processors and control

25 logic to process the signals received from the corresponding WLAN or BT receive signal path of the radio IC circuitry 106, and to also generate corresponding WLAN or BT baseband signals for the transmit signal path of the radio IC circuitry 106. Each of the baseband processing circuitries 108A and 108B may further include physical layer (PHY) and medium access control layer

30 (MAC) circuitry, and may further interface with application processor 111 for

generation and processing of the baseband signals and for controlling operations of the radio IC circuitry 106.

[0030] Referring still to FIG. 1, according to the shown embodiment, WLAN-BT coexistence circuitry 113 may include logic providing an interface
5 between the WLAN baseband circuitry 108A and the BT baseband circuitry 108B to enable use cases requiring WLAN and BT coexistence. In addition, a switch 103 may be provided between the WLAN FEM circuitry 104A and the BT FEM circuitry 104B to allow switching between the WLAN and BT radios according to application needs. In addition, although the antennas 101 are
10 depicted as being respectively connected to the WLAN FEM circuitry 104A and the BT FEM circuitry 104B, embodiments include within their scope the sharing of one or more antennas as between the WLAN and BT FEMs, or the provision of more than one antenna connected to each of FEM 104A or 104B.

[0031] In some embodiments, the front-end module circuitry 104, the
15 radio IC circuitry 106, and baseband processing circuitry 108 may be provided on a single radio card, such as wireless radio card 102. In some other embodiments, the one or more antennas 101, the FEM circuitry 104 and the radio IC circuitry 106 may be provided on a single radio card. In some other embodiments, the radio IC circuitry 106 and the baseband processing circuitry
20 108 may be provided on a single chip or integrated circuit (IC), such as IC 112.

[0032] In some embodiments, the wireless radio card 102 may include a WLAN radio card and may be configured for Wi-Fi communications, although the scope of the embodiments is not limited in this respect. In some of these
25 embodiments, the radio architecture 100 may be configured to receive and transmit orthogonal frequency division multiplexed (OFDM) or orthogonal frequency division multiple access (OFDMA) communication signals over a multicarrier communication channel. The OFDM or OFDMA signals may comprise a plurality of orthogonal subcarriers.

[0033] In some of these multicarrier embodiments, radio architecture 100
30 may be part of a Wi-Fi communication station (STA) such as a wireless access point (AP), a base station or a mobile device including a Wi-Fi device. In some

of these embodiments, radio architecture 100 may be configured to transmit and receive signals in accordance with specific communication standards and/or protocols, such as any of the Institute of Electrical and Electronics Engineers (IEEE) standards including, IEEE 802.11n-2009, IEEE 802.11-2012, IEEE 5 802.11-2016, IEEE 802.11ac, and/or IEEE 802.11ax standards and/or proposed specifications for WLANs, although the scope of embodiments is not limited in this respect. Radio architecture 100 may also be suitable to transmit and/or receive communications in accordance with other techniques and standards.

[0034] In some embodiments, the radio architecture 100 may be 10 configured for high-efficiency (HE) Wi-Fi (HEW) communications in accordance with the IEEE 802.11ax standard. In some embodiments, the radio architecture 100 may be configured for Extremely High Throughput (EHT) communications in accordance with the IEEE 802.11EHT standard. In these 15 embodiments, the radio architecture 100 may be configured to communicate in accordance with an OFDMA technique, although the scope of the embodiments is not limited in this respect.

[0035] In some other embodiments, the radio architecture 100 may be configured to transmit and receive signals transmitted using one or more other 20 modulation techniques such as spread spectrum modulation (e.g., direct sequence code division multiple access (DS-CDMA) and/or frequency hopping code division multiple access (FH-CDMA)), time-division multiplexing (TDM) modulation, and/or frequency-division multiplexing (FDM) modulation, although the scope of the embodiments is not limited in this respect.

[0036] In some embodiments, as further shown in FIG. 1, the BT 25 baseband circuitry 108B may be compliant with a Bluetooth (BT) connectivity standard such as Bluetooth, Bluetooth 4.0 or Bluetooth 5.0, or any other iteration of the Bluetooth Standard. In embodiments that include BT functionality as shown for example in Fig. 1, the radio architecture 100 may be configured to establish a BT synchronous connection oriented (SCO) link and/or a BT low 30 energy (BT LE) link. In some of the embodiments that include functionality, the radio architecture 100 may be configured to establish an extended SCO (eSCO)

link for BT communications, although the scope of the embodiments is not limited in this respect. In some of these embodiments that include a BT functionality, the radio architecture may be configured to engage in a BT Asynchronous Connection-Less (ACL) communications, although the scope of the embodiments is not limited in this respect. In some embodiments, as shown in FIG. 1, the functions of a BT radio card and WLAN radio card may be combined on a single wireless radio card, such as single wireless radio card 102, although embodiments are not so limited, and include within their scope discrete WLAN and BT radio cards

10 [0037] In some embodiments, the radio-architecture 100 may include other radio cards, such as a cellular radio card configured for cellular (e.g., 3GPP such as LTE, LTE-Advanced or 5G communications).

[0038] In some IEEE 802.11 embodiments, the radio architecture 100 may be configured for communication over various channel bandwidths including bandwidths having center frequencies of about 900 MHz, 2.4 GHz, 5 GHz, and bandwidths of about 1 MHz, 2 MHz, 2.5 MHz, 4 MHz, 5MHz, 8 MHz, 10 MHz, 16 MHz, 20 MHz, 40MHz, 80MHz (with contiguous bandwidths) or 80+80MHz (160MHz) (with non-contiguous bandwidths). In some embodiments, a 320 MHz channel bandwidth may be used. The scope of the embodiments is not limited with respect to the above center frequencies however.

[0039] FIG. 2 illustrates FEM circuitry 200 in accordance with some embodiments. The FEM circuitry 200 is one example of circuitry that may be suitable for use as the WLAN and/or BT FEM circuitry 104A/104B (FIG. 1), although other circuitry configurations may also be suitable.

[0040] In some embodiments, the FEM circuitry 200 may include a TX/RX switch 202 to switch between transmit mode and receive mode operation. The FEM circuitry 200 may include a receive signal path and a transmit signal path. The receive signal path of the FEM circuitry 200 may include a low-noise amplifier (LNA) 206 to amplify received RF signals 203 and provide the amplified received RF signals 207 as an output (e.g., to the radio IC

circuitry 106 (FIG. 1)). The transmit signal path of the circuitry 200 may include a power amplifier (PA) to amplify input RF signals 209 (e.g., provided by the radio IC circuitry 106), and one or more filters 212, such as band-pass filters (BPFs), low-pass filters (LPFs) or other types of filters, to generate RF signals
5 215 for subsequent transmission (e.g., by one or more of the antennas 101 (FIG. 1)).

[0041] In some dual-mode embodiments for Wi-Fi communication, the FEM circuitry 200 may be configured to operate in either the 2.4 GHz frequency spectrum or the 5 GHz frequency spectrum. In these embodiments, the receive
10 signal path of the FEM circuitry 200 may include a receive signal path duplexer 204 to separate the signals from each spectrum as well as provide a separate LNA 206 for each spectrum as shown. In these embodiments, the transmit signal path of the FEM circuitry 200 may also include a power amplifier 210 and a filter 212, such as a BPF, a LPF or another type of filter for each frequency
15 spectrum and a transmit signal path duplexer 214 to provide the signals of one of the different spectrums onto a single transmit path for subsequent transmission by the one or more of the antennas 101 (FIG. 1). In some embodiments, BT communications may utilize the 2.4 GHz signal paths and may utilize the same FEM circuitry 200 as the one used for WLAN communications.

20 [0042] FIG. 3 illustrates radio IC circuitry 300 in accordance with some embodiments. The radio IC circuitry 300 is one example of circuitry that may be suitable for use as the WLAN or BT radio IC circuitry 106A/106B (FIG. 1), although other circuitry configurations may also be suitable.

[0043] In some embodiments, the radio IC circuitry 300 may include a
25 receive signal path and a transmit signal path. The receive signal path of the radio IC circuitry 300 may include at least mixer circuitry 302, such as, for example, down-conversion mixer circuitry, amplifier circuitry 306 and filter circuitry 308. The transmit signal path of the radio IC circuitry 300 may include at least filter circuitry 312 and mixer circuitry 314, such as, for example, up-
30 conversion mixer circuitry. Radio IC circuitry 300 may also include synthesizer circuitry 304 for synthesizing a frequency 305 for use by the mixer circuitry 302

and the mixer circuitry 314. The mixer circuitry 302 and/or 314 may each, according to some embodiments, be configured to provide direct conversion functionality. The latter type of circuitry presents a much simpler architecture as compared with standard super-heterodyne mixer circuitries, and any flicker noise brought about by the same may be alleviated for example through the use of OFDM modulation. Fig. 3 illustrates only a simplified version of a radio IC circuitry, and may include, although not shown, embodiments where each of the depicted circuitries may include more than one component. For instance, mixer circuitry 320 and/or 314 may each include one or more mixers, and filter circuitries 308 and/or 312 may each include one or more filters, such as one or more BPFs and/or LPFs according to application needs. For example, when mixer circuitries are of the direct-conversion type, they may each include two or more mixers.

[0044] In some embodiments, mixer circuitry 302 may be configured to down-convert RF signals 207 received from the FEM circuitry 104 (FIG. 1) based on the synthesized frequency 305 provided by synthesizer circuitry 304. The amplifier circuitry 306 may be configured to amplify the down-converted signals and the filter circuitry 308 may include a LPF configured to remove unwanted signals from the down-converted signals to generate output baseband signals 307. Output baseband signals 307 may be provided to the baseband processing circuitry 108 (FIG. 1) for further processing. In some embodiments, the output baseband signals 307 may be zero-frequency baseband signals, although this is not a requirement. In some embodiments, mixer circuitry 302 may comprise passive mixers, although the scope of the embodiments is not limited in this respect.

[0045] In some embodiments, the mixer circuitry 314 may be configured to up-convert input baseband signals 311 based on the synthesized frequency 305 provided by the synthesizer circuitry 304 to generate RF output signals 209 for the FEM circuitry 104. The baseband signals 311 may be provided by the baseband processing circuitry 108 and may be filtered by filter circuitry 312. The

filter circuitry 312 may include a LPF or a BPF, although the scope of the embodiments is not limited in this respect.

[0046] In some embodiments, the mixer circuitry 302 and the mixer circuitry 314 may each include two or more mixers and may be arranged for quadrature down-conversion and/or up-conversion respectively with the help of synthesizer 304. In some embodiments, the mixer circuitry 302 and the mixer circuitry 314 may each include two or more mixers each configured for image rejection (e.g., Hartley image rejection). In some embodiments, the mixer circuitry 302 and the mixer circuitry 314 may be arranged for direct down-conversion and/or direct up-conversion, respectively. In some embodiments, the mixer circuitry 302 and the mixer circuitry 314 may be configured for super-heterodyne operation, although this is not a requirement.

[0047] Mixer circuitry 302 may comprise, according to one embodiment: quadrature passive mixers (e.g., for the in-phase (I) and quadrature phase (Q) paths). In such an embodiment, RF input signal 207 from Fig. 3 may be down-converted to provide I and Q baseband output signals to be sent to the baseband processor

[0048] Quadrature passive mixers may be driven by zero and ninety-degree time-varying LO switching signals provided by a quadrature circuitry which may be configured to receive a LO frequency (f_{LO}) from a local oscillator or a synthesizer, such as LO frequency 305 of synthesizer 304 (FIG. 3). In some embodiments, the LO frequency may be the carrier frequency, while in other embodiments, the LO frequency may be a fraction of the carrier frequency (e.g., one-half the carrier frequency, one-third the carrier frequency). In some embodiments, the zero and ninety-degree time-varying switching signals may be generated by the synthesizer, although the scope of the embodiments is not limited in this respect.

[0049] In some embodiments, the LO signals may differ in duty cycle (the percentage of one period in which the LO signal is high) and/or offset (the difference between start points of the period). In some embodiments, the LO signals may have a 25% duty cycle and a 50% offset. In some embodiments,

each branch of the mixer circuitry (e.g., the in-phase (I) and quadrature phase (Q) path) may operate at a 25% duty cycle, which may result in a significant reduction in power consumption.

[0050] The RF input signal 207 (FIG. 2) may comprise a balanced
5 signal, although the scope of the embodiments is not limited in this respect. The I and Q baseband output signals may be provided to low-noise amplifier, such as amplifier circuitry 306 (FIG. 3) or to filter circuitry 308 (FIG. 3).

[0051] In some embodiments, the output baseband signals 307 and the
10 input baseband signals 311 may be analog baseband signals, although the scope of the embodiments is not limited in this respect. In some alternate embodiments, the output baseband signals 307 and the input baseband signals 311 may be digital baseband signals. In these alternate embodiments, the radio IC circuitry may include analog-to-digital converter (ADC) and digital-to-analog converter (DAC) circuitry.

[0052] In some dual-mode embodiments, a separate radio IC circuitry
15 may be provided for processing signals for each spectrum, or for other spectrums not mentioned here, although the scope of the embodiments is not limited in this respect.

[0053] In some embodiments, the synthesizer circuitry 304 may be a
20 fractional-N synthesizer or a fractional N/N+1 synthesizer, although the scope of the embodiments is not limited in this respect as other types of frequency synthesizers may be suitable. For example, synthesizer circuitry 304 may be a delta-sigma synthesizer, a frequency multiplier, or a synthesizer comprising a phase-locked loop with a frequency divider. According to some embodiments,
25 the synthesizer circuitry 304 may include digital synthesizer circuitry. An advantage of using a digital synthesizer circuitry is that, although it may still include some analog components, its footprint may be scaled down much more than the footprint of an analog synthesizer circuitry. In some embodiments, frequency input into synthesizer circuitry 304 may be provided by a voltage
30 controlled oscillator (VCO), although that is not a requirement. A divider control input may further be provided by either the baseband processing circuitry 108

(FIG. 1) or the application processor 111 (FIG. 1) depending on the desired output frequency 305. In some embodiments, a divider control input (e.g., N) may be determined from a look-up table (e.g., within a Wi-Fi card) based on a channel number and a channel center frequency as determined or indicated by the application processor 111.

[0054] In some embodiments, synthesizer circuitry 304 may be configured to generate a carrier frequency as the output frequency 305, while in other embodiments, the output frequency 305 may be a fraction of the carrier frequency (e.g., one-half the carrier frequency, one-third the carrier frequency). In some embodiments, the output frequency 305 may be a LO frequency (f_{LO}).

[0055] FIG. 4 illustrates a functional block diagram of baseband processing circuitry 400 in accordance with some embodiments. The baseband processing circuitry 400 is one example of circuitry that may be suitable for use as the baseband processing circuitry 108 (FIG. 1), although other circuitry configurations may also be suitable. The baseband processing circuitry 400 may include a receive baseband processor (RX BBP) 402 for processing receive baseband signals 309 provided by the radio IC circuitry 106 (FIG. 1) and a transmit baseband processor (TX BBP) 404 for generating transmit baseband signals 311 for the radio IC circuitry 106. The baseband processing circuitry 400 may also include control logic 406 for coordinating the operations of the baseband processing circuitry 400.

[0056] In some embodiments (e.g., when analog baseband signals are exchanged between the baseband processing circuitry 400 and the radio IC circuitry 106), the baseband processing circuitry 400 may include ADC 410 to convert analog baseband signals received from the radio IC circuitry 106 to digital baseband signals for processing by the RX BBP 402. In these embodiments, the baseband processing circuitry 400 may also include DAC 412 to convert digital baseband signals from the TX BBP 404 to analog baseband signals.

[0057] In some embodiments that communicate OFDM signals or OFDMA signals, such as through baseband processor 108A, the transmit

baseband processor 404 may be configured to generate OFDM or OFDMA signals as appropriate for transmission by performing an inverse fast Fourier transform (IFFT). The receive baseband processor 402 may be configured to process received OFDM signals or OFDMA signals by performing an FFT. In some embodiments, the receive baseband processor 402 may be configured to detect the presence of an OFDM signal or OFDMA signal by performing an autocorrelation, to detect a preamble, such as a short preamble, and by performing a cross-correlation, to detect a long preamble. The preambles may be part of a predetermined frame structure for Wi-Fi communication.

10 [0058] Referring back to FIG. 1, in some embodiments, the antennas 101 (FIG. 1) may each comprise one or more directional or omnidirectional antennas, including, for example, dipole antennas, monopole antennas, patch antennas, loop antennas, microstrip antennas or other types of antennas suitable for transmission of RF signals. In some multiple-input multiple-output (MIMO) 15 embodiments, the antennas may be effectively separated to take advantage of spatial diversity and the different channel characteristics that may result. Antennas 101 may each include a set of phased-array antennas, although embodiments are not so limited.

[0059] Although the radio-architecture 100 is illustrated as having 20 several separate functional elements, one or more of the functional elements may be combined and may be implemented by combinations of software-configured elements, such as processing elements including digital signal processors (DSPs), and/or other hardware elements. For example, some elements may comprise one or more microprocessors, DSPs, field-programmable gate arrays 25 (FPGAs), application specific integrated circuits (ASICs), radio-frequency integrated circuits (RFICs) and combinations of various hardware and logic circuitry for performing at least the functions described herein. In some embodiments, the functional elements may refer to one or more processes operating on one or more processing elements.

30 [0060] FIG. 5 illustrates a WLAN 500 in accordance with some embodiments. The WLAN 500 may comprise a BSS that may include a HE

access point (AP) 502, a 6 GHz HE AP 503, a plurality of HE stations (STAs) (e.g., IEEE 802.11ax) 504, a plurality of 6 GHz HE STAs, and a plurality of legacy (e.g., IEEE 802.11n/ac) devices 506. In some embodiments, a HE AP 502, a 6 GHz HE AP 503, a HE STA 504, and/or a 6 GHz HE STA may be a HE STA 504 and/or HE AP 502 configured to operate in the 6 GHz band, e.g., 6 to 7 GHz. In some embodiments, a HE AP 502, a 6 GHz HE AP 503, a HE STA 504, and/or a 6 GHz HE STA may be configured to operate in accordance with IEEE 802.11EHT.

[0061] The HE AP 502 may be an AP using the IEEE 802.11 to transmit and receive. The HE AP 502 may be a base station. The HE AP 502 may use other communications protocols as well as the IEEE 802.11 protocol. The IEEE 802.11 protocol may be IEEE 802.11ax. The IEEE 802.11 protocol may include using orthogonal frequency division multiple-access (OFDMA), time division multiple access (TDMA), and/or code division multiple access (CDMA). The IEEE 802.11 protocol may include a multiple access technique. For example, the IEEE 802.11 protocol may include space-division multiple access (SDMA) and/or multiple-user multiple-input multiple-output (MU-MIMO). There may be more than one HE AP 502 and/or 6 GHz HE AP 503 that are part of an extended service set (ESS). A controller (not illustrated) may store information that is common to the more than one HE APs 502 and/or 6 GHz HE APs 503. The controller may have access to external networks such as the internet. The ESS may have an ID and/or a color.

[0062] The legacy devices 506 may operate in accordance with one or more of IEEE 802.11 a/b/g/n/ac/ad/af/ah/aj/ay, or another legacy wireless communication standard. The legacy devices 506 may be STAs or IEEE STAs. The HE STAs 504 may be wireless transmit and receive devices such as cellular telephone, portable electronic wireless communication devices, smart telephone, handheld wireless device, wireless glasses, wireless watch, wireless personal device, tablet, or another device that may be transmitting and receiving using the IEEE 802.11 protocol such as IEEE 802.11ax or another wireless protocol.

[0063] The HE AP 502 may communicate with legacy devices 506 in accordance with legacy IEEE 802.11 communication techniques. In example embodiments, the HE AP 502 may also be configured to communicate with HE STAs 504 in accordance with legacy IEEE 802.11 communication techniques.

5 [0064] In some embodiments, a HE frame may be configurable to have the same bandwidth as a channel. The HE frame may be a physical Layer Convergence Procedure (PLCP) Protocol Data Unit (PPDU). In some embodiments, there may be different types of PPDU that may have different fields and different physical layers and/or different media access control (MAC) layers.

10 [0065] The bandwidth of a channel may be 20MHz, 40MHz, or 80MHz, 160MHz, 320MHz contiguous bandwidths or an 80+80MHz (160MHz) non-contiguous bandwidth. In some embodiments, the bandwidth of a channel may be 1 MHz, 1.25MHz, 2.03MHz, 2.5MHz, 4.06 MHz, 5MHz and 10MHz, or a combination thereof or another bandwidth that is less or equal to the available bandwidth may also be used. In some embodiments the bandwidth of the channels may be based on a number of active data subcarriers. In some embodiments the bandwidth of the channels is based on 26, 52, 106, 242, 484, 996, or 2x996 active data subcarriers or tones that are spaced by 20 MHz. In 15 some embodiments the bandwidth of the channels is 256 tones spaced by 20 MHz. In some embodiments the channels are multiple of 26 tones or a multiple of 20 MHz. In some embodiments a 20 MHz channel may comprise 242 active data subcarriers or tones, which may determine the size of a Fast Fourier Transform (FFT). An allocation of a bandwidth or a number of tones or subcarriers may be termed a resource unit (RU) allocation in accordance with some 20 embodiments.

[0066] In some embodiments, the 26-subcarrier RU and 52-subcarrier RU are used in the 20 MHz, 40 MHz, 80 MHz, 160 MHz and 80+80 MHz OFDMA HE PPDU formats. In some embodiments, the 106-subcarrier RU is 30 used in the 20 MHz, 40 MHz, 80 MHz, 160 MHz and 80+80 MHz OFDMA and MU-MIMO HE PPDU formats. In some embodiments, the 242-subcarrier RU is

used in the 40 MHz, 80 MHz, 160 MHz and 80+80 MHz OFDMA and MU-MIMO HE PPDU formats. In some embodiments, the 484-subcarrier RU is used in the 80 MHz, 160 MHz and 80+80 MHz OFDMA and MU-MIMO HE PPDU formats. In some embodiments, the 996-subcarrier RU is used in the 160
5 MHz and 80+80 MHz OFDMA and MU-MIMO HE PPDU formats.

[0067] A HE frame may be configured for transmitting a number of spatial streams, which may be in accordance with MU-MIMO and may be in accordance with OFDMA. In other embodiments, the HE AP 502, HE STA 504, and/or legacy device 506 may also implement different technologies such as
10 code division multiple access (CDMA) 2000, CDMA 2000 1X, CDMA 2000 Evolution-Data Optimized (EV-DO), Interim Standard 2000 (IS-2000), Interim Standard 95 (IS-95), Interim Standard 856 (IS-856), Long Term Evolution (LTE), Global System for Mobile communications (GSM), Enhanced Data rates for GSM Evolution (EDGE), GSM EDGE (GERAN), IEEE 802.16 (i.e.,
15 Worldwide Interoperability for Microwave Access (WiMAX)), BlueTooth®, or other technologies.

[0068] Some embodiments relate to HE communications. In accordance with some IEEE 802.11 embodiments, e.g., IEEE 802.11ax embodiments, a HE AP 502 may operate as a master station which may be arranged to contend for a
20 wireless medium (e.g., during a contention period) to receive exclusive control of the medium for an HE control period. In some embodiments, the HE control period may be termed a transmission opportunity (TXOP). The HE AP 502 may transmit a HE master-sync transmission, which may be a trigger frame or HE control and schedule transmission, at the beginning of the HE control period.
25 The HE AP 502 may transmit a time duration of the TXOP and sub-channel information. During the HE control period, HE STAs 504 may communicate with the HE AP 502 in accordance with a non-contention based multiple access technique such as OFDMA or MU-MIMO. This is unlike conventional WLAN communications in which devices communicate in accordance with a contention-
30 based communication technique, rather than a multiple access technique. During the HE control period, the HE AP 502 may communicate with HE STAs 504

using one or more HE frames. During the HE control period, the HE STAs 504 may operate on a sub-channel smaller than the operating range of the HE AP 502. During the HE control period, legacy stations refrain from communicating. The legacy stations may need to receive the communication from the HE AP 502 to defer from communicating.

[0069] In accordance with some embodiments, during the TXOP the HE STAs 504 may contend for the wireless medium with the legacy devices 506 being excluded from contending for the wireless medium during the master-sync transmission. In some embodiments the trigger frame may indicate an uplink (UL) UL-MU-MIMO and/or UL OFDMA TXOP. In some embodiments, the trigger frame may include a DL UL-MU-MIMO and/or DL OFDMA with a schedule indicated in a preamble portion of trigger frame.

[0070] In some embodiments, the multiple-access technique used during the HE TXOP may be a scheduled OFDMA technique, although this is not a requirement. In some embodiments, the multiple access technique may be a time-division multiple access (TDMA) technique or a frequency division multiple access (FDMA) technique. In some embodiments, the multiple access technique may be a space-division multiple access (SDMA) technique. In some embodiments, the multiple access technique may be a Code division multiple access (CDMA).

[0071] The HE AP 502 may also communicate with legacy stations 506 and/or HE STAs 504 in accordance with legacy IEEE 802.11 communication techniques. In some embodiments, the HE AP 502 may also be configurable to communicate with HE STAs 504 outside the HE TXOP in accordance with legacy IEEE 802.11 communication techniques, although this is not a requirement.

[0072] In some embodiments the HE STA 504 may be a “group owner” (GO) for peer-to-peer modes of operation. A wireless device may be a HE STA 502 or a HE AP 502. In some embodiments, the HE station 504 and/or HE AP 502 may be configured to operate in accordance with IEEE 802.11mc.

[0073] A 6 GHz HE STA 505 may be a HE STA 504 that is further configured to operate in the 6 to 7 GHz band. A 6 GHz HE AP 503 may be a HE AP 502 that is configured to operate in the 6 to 7 GHz band. The HE STA 504 and/or HE AP 502 may be configured to operate on one or both of the 2.4
5 GHz band and the 5 GHz band, as well as the 6 GHz band.

[0074] In example embodiments, the radio architecture of FIG. 1 is configured to implement the HE station 504, the HE AP 502, the 6 GHz HE STA 505 and/or the 6 GHz HE AP 503. In example embodiments, the front-end module circuitry of FIG. 2 is configured to implement the HE station 504, the
10 HE AP 502, the 6 GHz HE STA 505 and/or the 6 GHz HE AP 503. In example embodiments, the radio IC circuitry of FIG. 3 is configured to implement the HE station 504, the HE AP 502, the 6 GHz HE STA 505 and/or the 6 GHz HE AP 503. In example embodiments, the base-band processing circuitry of FIG. 4 is configured to implement the HE station 504, the HE AP 502, the 6 GHz HE
15 STA 505 and/or the 6 GHz HE AP 503.

[0075] In example embodiments, the HE station 504, the HE AP 502, the 6 GHz HE STA 505, the 6 GHz HE AP 503, an apparatus of HE station 504, an apparatus of HE AP 502, an apparatus of 6 GHz HE STA 505 and/or an apparatus of 6 GHz HE AP 503 may include one or more of the following: the
20 radio architecture of FIG. 1, the front-end module circuitry of FIG. 2, the radio IC circuitry of FIG. 3, and/or the base-band processing circuitry of FIG. 4.

[0076] In example embodiments, the radio architecture of FIG. 1, the front-end module circuitry of FIG. 2, the radio IC circuitry of FIG. 3, and/or the base-band processing circuitry of FIG. 4 may be configured to perform the
25 methods and operations/functions herein described in conjunction with FIGS. 1-20.

[0077] In example embodiments, the HE station 504, the HE AP 502, the 6 GHz HE STA 505, the 6 GHz HE AP 503, an apparatus of HE station 504, an apparatus of HE AP 502, an apparatus of 6 GHz HE STA 505 and/or an
30 apparatus of 6 GHz HE AP 503 are configured to perform the methods and operations/functions described herein in conjunction with FIGS. 1-20. The term

Wi-Fi may refer to one or more of the IEEE 802.11 communication standards.

AP and STA may refer to HE access point 502, HE station 504, 6 GHz HE STA 505, and/or 6 GHz HE AP 503 as well as legacy devices 506.

[0078] In some embodiments, a HE AP STA may refer to a HE AP 502,
5 a HE STAs 504, a 6 GHz HE STA 505, and/or a 6 GHz HE AP 503 that is
operating as a 6 GHz HE AP 503 or HE APs 502. In some embodiments, when
an HE STA 504 or 6 GHz HE STA 505 is not operating as a HE AP, it may be
referred to as a HE non-AP STA or HE non-AP. In some embodiments, HE
STA 504 may be referred to as either a HE AP STA or a HE non-AP.

10 [0079] In some embodiments, 6 GHz HE STA 505 and/or 6 GHz HE AP
503 may be configured to operate in greenfield mode in the 6 GHz band. A
greenfield mode may be operation that does not accommodate some or all legacy
device protocols. In some embodiments, a greenfield mode may improve the
performance of the 6 GHz HE STA 505 and/or 6 GHz HE AP 503.

15 [0080] In some embodiments, 6 GHz HE STA 505 and/or 6 GHz HE AP
503 may receive instructions to not access the 6 GHz band, e.g., a 6 GHz HE AP
503 may instruct a 6 GHz HE STA 505 not to access the 6 GHz band. In some
embodiments, 6 GHz HE STA 505 and/or 6 GHz HE AP 503 may use channels
of 20 MHz, 40 MHz, 80 MHz, 160 MHz, 80+80 MHz, 320 MHz, 640 MHz for
20 communicating with other 6 GHz devices. In some embodiments, 6 GHz HE
STA 505 and/or 6 GHz HE AP 503 may use channels less than 20 MHz. In
some embodiments, 6 GHz HE STA 505 and/or 6 GHz HE AP 503 may be
configured to use only channels of a particular size or greater, e.g., 20 MHz, 40
MHz, etc. In some embodiments, 6 GHz HE STA 505 and/or 6 GHz HE AP 503
25 may be configured to operate on a primary channel that is greater than 20 MHz.

[0081] In some embodiments, 6 GHz HE STA 505 and/or 6 GHz HE AP
503 may operate on a multiply bands, e.g., 2.4 GHz, 5 GHz, and 6 GHz. In
some embodiments, HE STA 504 and/or HE AP 502 may operate on 2.4 GHz
and/or 5 GHz.

30 [0082] In some embodiments, 6 GHz HE STA 505 and/or 6 GHz HE AP
503 are configured to not transmit association requests in the 6 GHz band. In

some embodiments, the 6 GHz HE STA 505 and/or 6 GHz HE AP 503 associate first at the 2.4 GHz or 5 GHz band, and then communicate on the 6 GHz band.

In some embodiments, mobility at 6 GHz band is performed only with BSS transition management (BTM) and/or optimized connectivity experience (OCE),
5 e.g., as disclosed in IEEE 802.11 with 6 GHz band additions and multi-band operation (MBO) enhancements.

[0083] In some embodiments, the 6 GHz HE AP 503 may signal the 6 GHz HE STA 505 the existence of a second 6 GHz HE AP 503 with a specific channel and request or require the 6 GHz HE STA 505 to re-associate with the
10 second 6 GHz HE AP 503. In some embodiments, the 6 GHz HE AP 503 may transmit reduced neighbor reports, e.g., 1300, elements in beacons that include a list of neighbor report elements in beacons that include a list of neighbor 6 GHz HE APs 503 with their operating channels and target beacon transmission times (TBTTs).

[0084] In some embodiments, 6 GHz HE STAs 505 must support one of 2.4 GHz band and 5 GHz band, and 6 GHz band. In some embodiments, 6 GHz HE STAs 505 is not permitted to perform active scanning in the 6 GHz band. In some embodiments, 6 GHz HE STAs 505 is not permitted to send an association request frame on the 6 GHz band. In some embodiments, 6 GHz HE STAs 505
20 first associate with a HE AP 502 or 6 GHz HE AP 503 on a 2.4 or 5 GHz band and exchange multi-band capabilities and support for the 6 GHz interface. In some embodiments, 6 GHz HE STAs 505 may communicate over the 6 GHz band after exchanging 6 GHz capabilities over a 2.4 or 5 GHz band. In some embodiments, 6 GHz HE STAs 505 are configured to operate in accordance with
25 BTM protocol. In some embodiments, 6 GHz HE STAs 505 is configured to send a re-association request to a first 6 GHz HE AP 503 when requested to transition to the first 6 GHz HE AP 503 from a second 6 GHz HE AP 503. In some embodiments, 6 GHz HE STAs 505 are configured to move back to a 2.4 or 5 GHz band when requested or required to by a 6 GHz HE AP 503, e.g., via
30 BTM. In some embodiments, 6 GHz HE STAs 505 may transition to (e.g., disassociate from the second 6 GHz HE AP 503 and associate with the first 6

GHz HE AP 503) a first 6 GHz HE AP 503 when requested or required to by a second 6 GHz HE AP 503, e.g., via BTM.

[0085] In some embodiments, 6 GHz HE APs 503 must support one of 2.4 GHz band and 5 GHz band, and 6 GHz band. In some embodiments, 6 GHz HE APs 503 send beacons with an interval longer than 100 ms. In some embodiments, 6 GHz HE APs 503 are configured to not respond to probe requests at 6 GHz band. In some embodiments, 6 GHz HE APs 503 are configured to not respond to association requests at 6 GHz band, but to respond to re-association requests at 6 GHz band. In some embodiments, 6 GHz HE APs 503 are configured to support MBO. In some embodiments, 6 GHz HE APs 503 are configured to operate in accordance with admission control for the 6 GHz band for 6GHz HE STAs 505 in accordance with BTM protocols with solicited and unsolicited methods.

[0086] FIG. 6 illustrates a block diagram of an example machine 600 upon which any one or more of the techniques (e.g., methodologies) discussed herein may perform. In alternative embodiments, the machine 600 may operate as a standalone device or may be connected (e.g., networked) to other machines. In a networked deployment, the machine 600 may operate in the capacity of a server machine, a client machine, or both in server-client network environments. In an example, the machine 600 may act as a peer machine in peer-to-peer (P2P) (or other distributed) network environment. The machine 600 may be a HE AP 502 (or apparatus of), HE station 504(or apparatus of), 6 GHz HE STA 505(or apparatus of), 6 GHz HE AP 503(or apparatus of), personal computer (PC), a tablet PC, a set-top box (STB), a personal digital assistant (PDA), a portable communications device, a mobile telephone, a smart phone, a web appliance, a network router, switch or bridge, or any machine capable of executing instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more

of the methodologies discussed herein, such as cloud computing, software as a service (SaaS), other computer cluster configurations.

[0087] Machine (e.g., computer system) 600 may include a hardware processor 602 (e.g., a central processing unit (CPU), a graphics processing unit (GPU), a hardware processor core, or any combination thereof), a main memory 5 604 and a static memory 606, some or all of which may communicate with each other via an interlink (e.g., bus) 608.

[0088] Specific examples of main memory 604 include Random Access Memory (RAM), and semiconductor memory devices, which may include, in 10 some embodiments, storage locations in semiconductors such as registers. Specific examples of static memory 606 include non-volatile memory, such as semiconductor memory devices (e.g., Electrically Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM)) and flash memory devices; magnetic disks, such as internal hard 15 disks and removable disks; magneto-optical disks; RAM; and CD-ROM and DVD-ROM disks.

[0089] The machine 600 may further include a display device 610, an input device 612 (e.g., a keyboard), and a user interface (UI) navigation device 614 (e.g., a mouse). In an example, the display device 610, input device 612 and 20 UI navigation device 614 may be a touch screen display. The machine 600 may additionally include a mass storage (e.g., drive unit) 616, a signal generation device 618 (e.g., a speaker), a network interface device 620, and one or more sensors 621, such as a global positioning system (GPS) sensor, compass, accelerometer, or other sensor. The machine 600 may include an output 25 controller 628, such as a serial (e.g., universal serial bus (USB), parallel, or other wired or wireless (e.g., infrared (IR), near field communication (NFC), etc.) connection to communicate or control one or more peripheral devices (e.g., a printer, card reader, etc.). In some embodiments the processor 602 and/or instructions 624 may comprise processing circuitry and/or transceiver circuitry.

30 [0090] The storage device 616 may include a machine readable medium 622 on which is stored one or more sets of data structures or instructions 624

(e.g., software) embodying or utilized by any one or more of the techniques or functions described herein. The instructions 624 may also reside, completely or at least partially, within the main memory 604, within static memory 606, or within the hardware processor 602 during execution thereof by the machine 600.

- 5 In an example, one or any combination of the hardware processor 602, the main memory 604, the static memory 606, or the storage device 616 may constitute machine readable media.

[0091] Specific examples of machine readable media may include: non-volatile memory, such as semiconductor memory devices (e.g., EPROM or
10 EEPROM) and flash memory devices; magnetic disks, such as internal hard disks and removable disks; magneto-optical disks; RAM; and CD-ROM and DVD-ROM disks.

[0092] While the machine readable medium 622 is illustrated as a single medium, the term "machine readable medium" may include a single medium or
15 multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) configured to store the one or more instructions 624.

[0093] An apparatus of the machine 600 may be one or more of a hardware processor 602 (e.g., a central processing unit (CPU), a graphics processing unit (GPU), a hardware processor core, or any combination thereof),
20 a main memory 604 and a static memory 606, sensors 621, network interface device 620, antennas 660, a display device 610, an input device 612, a UI navigation device 614, a mass storage 616, instructions 624, a signal generation device 618, and an output controller 628. The apparatus may be configured to perform one or more of the methods and/or operations disclosed herein. The
25 apparatus may be intended as a component of the machine 600 to perform one or more of the methods and/or operations disclosed herein, and/or to perform a portion of one or more of the methods and/or operations disclosed herein. In some embodiments, the apparatus may include a pin or other means to receive power. In some embodiments, the apparatus may include power conditioning
30 hardware.

[0094] The term “machine readable medium” may include any medium that is capable of storing, encoding, or carrying instructions for execution by the machine 600 and that cause the machine 600 to perform any one or more of the techniques of the present disclosure, or that is capable of storing, encoding or carrying data structures used by or associated with such instructions. Non-limiting machine readable medium examples may include solid-state memories, and optical and magnetic media. Specific examples of machine readable media may include: non-volatile memory, such as semiconductor memory devices (e.g., Electrically Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM)) and flash memory devices; magnetic disks, such as internal hard disks and removable disks; magneto-optical disks; Random Access Memory (RAM); and CD-ROM and DVD-ROM disks. In some examples, machine readable media may include non-transitory machine readable media. In some examples, machine readable media may include machine readable media that is not a transitory propagating signal.

[0095] The instructions 624 may further be transmitted or received over a communications network 626 using a transmission medium via the network interface device 620 utilizing any one of a number of transfer protocols (e.g., frame relay, internet protocol (IP), transmission control protocol (TCP), user datagram protocol (UDP), hypertext transfer protocol (HTTP), etc.). Example communication networks may include a local area network (LAN), a wide area network (WAN), a packet data network (e.g., the Internet), mobile telephone networks (e.g., cellular networks), Plain Old Telephone (POTS) networks, and wireless data networks (e.g., Institute of Electrical and Electronics Engineers (IEEE) 802.11 family of standards known as Wi-Fi®, IEEE 802.16 family of standards known as WiMax®, IEEE 802.15.4 family of standards, a Long Term Evolution (LTE) family of standards, a Universal Mobile Telecommunications System (UMTS) family of standards, peer-to-peer (P2P) networks, among others.

[0096] In an example, the network interface device 620 may include one or more physical jacks (e.g., Ethernet, coaxial, or phone jacks) or one or more

antennas to connect to the communications network 626. In an example, the network interface device 620 may include one or more antennas 660 to wirelessly communicate using at least one of single-input multiple-output (SIMO), multiple-input multiple-output (MIMO), or multiple-input single-output (MISO) techniques. In some examples, the network interface device 620 may wirelessly communicate using Multiple User MIMO techniques. The term “transmission medium” shall be taken to include any intangible medium that is capable of storing, encoding or carrying instructions for execution by the machine 600, and includes digital or analog communications signals or other intangible medium to facilitate communication of such software.

[0097] Examples, as described herein, may include, or may operate on, logic or a number of components, modules, or mechanisms. Modules are tangible entities (e.g., hardware) capable of performing specified operations and may be configured or arranged in a certain manner. In an example, circuits may be arranged (e.g., internally or with respect to external entities such as other circuits) in a specified manner as a module. In an example, the whole or part of one or more computer systems (e.g., a standalone, client or server computer system) or one or more hardware processors may be configured by firmware or software (e.g., instructions, an application portion, or an application) as a module that operates to perform specified operations. In an example, the software may reside on a machine readable medium. In an example, the software, when executed by the underlying hardware of the module, causes the hardware to perform the specified operations.

[0098] Accordingly, the term “module” is understood to encompass a tangible entity, be that an entity that is physically constructed, specifically configured (e.g., hardwired), or temporarily (e.g., transitorily) configured (e.g., programmed) to operate in a specified manner or to perform part or all of any operation described herein. Considering examples in which modules are temporarily configured, each of the modules need not be instantiated at any one moment in time. For example, where the modules comprise a general-purpose hardware processor configured using software, the general-purpose hardware

processor may be configured as respective different modules at different times. Software may accordingly configure a hardware processor, for example, to constitute a particular module at one instance of time and to constitute a different module at a different instance of time.

- 5 [0099] Some embodiments may be implemented fully or partially in software and/or firmware. This software and/or firmware may take the form of instructions contained in or on a non-transitory computer-readable storage medium. Those instructions may then be read and executed by one or more processors to enable performance of the operations described herein. The
- 10 instructions may be in any suitable form, such as but not limited to source code, compiled code, interpreted code, executable code, static code, dynamic code, and the like. Such a computer-readable medium may include any tangible non-transitory medium for storing information in a form readable by one or more computers, such as but not limited to read only memory (ROM); random access
- 15 memory (RAM); magnetic disk storage media; optical storage media; flash memory, etc.

- [00100] FIG. 7 illustrates a block diagram of an example wireless device 700 upon which any one or more of the techniques (e.g., methodologies or operations) discussed herein may perform. The wireless device 700 may be a
- 20 HE device or 6 GHz HE device. The wireless device 700 may be a 6 GHz HE STA 505 (or apparatus of), HE STA 504 (or apparatus of), 6 GHz HE AP 503 (or apparatus of), and/or HE AP 502 (or apparatus of) (e.g., FIG. 5). A 6 GHz HE STA 505 (or apparatus of), HE STA 504 (or apparatus of), 6 GHz HE AP 503 (or apparatus of), and/or HE AP 502 (or apparatus of) may include some or
- 25 all of the components shown in FIGS. 1-7. The wireless device 700 may be an example machine 600 as disclosed in conjunction with FIG. 6.

- [00101] The wireless device 700 may include processing circuitry 708. The processing circuitry 708 may include a transceiver 702, physical layer circuitry (PHY circuitry) 704, and MAC layer circuitry (MAC circuitry) 706,
- 30 one or more of which may enable transmission and reception of signals to and from other wireless devices 700 (e.g., HE AP 502, HE STA 504, and/or legacy

devices 506) using one or more antennas 712. As an example, the PHY circuitry 704 may perform various encoding and decoding functions that may include formation of baseband signals for transmission and decoding of received signals. As another example, the transceiver 702 may perform various transmission and reception functions such as conversion of signals between a baseband range and a Radio Frequency (RF) range.

[00102] Accordingly, the PHY circuitry 704 and the transceiver 702 may be separate components or may be part of a combined component, e.g., processing circuitry 708. In addition, some of the described functionality related to transmission and reception of signals may be performed by a combination that may include one, any or all of the PHY circuitry 704 the transceiver 702, MAC circuitry 706, memory 710, and other components or layers. The MAC circuitry 706 may control access to the wireless medium. The wireless device 700 may also include memory 710 arranged to perform the operations described herein, e.g., some of the operations described herein may be performed by instructions stored in the memory 710.

[00103] The antennas 712 (some embodiments may include only one antenna) may comprise one or more directional or omnidirectional antennas, including, for example, dipole antennas, monopole antennas, patch antennas, loop antennas, microstrip antennas or other types of antennas suitable for transmission of RF signals. In some multiple-input multiple-output (MIMO) embodiments, the antennas 712 may be effectively separated to take advantage of spatial diversity and the different channel characteristics that may result.

[00104] One or more of the memory 710, the transceiver 702, the PHY circuitry 704, the MAC circuitry 706, the antennas 712, and/or the processing circuitry 708 may be coupled with one another. Moreover, although memory 710, the transceiver 702, the PHY circuitry 704, the MAC circuitry 706, the antennas 712 are illustrated as separate components, one or more of memory 710, the transceiver 702, the PHY circuitry 704, the MAC circuitry 706, the antennas 712 may be integrated in an electronic package or chip.

[00105] In some embodiments, the wireless device 700 may be a mobile device as described in conjunction with FIG. 6. In some embodiments the wireless device 700 may be configured to operate in accordance with one or more wireless communication standards as described herein (e.g., as described in
5 conjunction with FIGS. 1-6, IEEE 802.11). In some embodiments, the wireless device 700 may include one or more of the components as described in conjunction with FIG. 6 (e.g., display device 610, input device 612, etc.) Although the wireless device 700 is illustrated as having several separate functional elements, one or more of the functional elements may be combined
10 and may be implemented by combinations of software-configured elements, such as processing elements including digital signal processors (DSPs), and/or other hardware elements. For example, some elements may comprise one or more microprocessors, DSPs, field-programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), radio-frequency integrated
15 circuits (RFICs) and combinations of various hardware and logic circuitry for performing at least the functions described herein. In some embodiments, the functional elements may refer to one or more processes operating on one or more processing elements.

[00106] In some embodiments, an apparatus of or used by the wireless
20 device 700 may include various components of the wireless device 700 as shown in FIG. 7 and/or components from FIGS. 1-6. Accordingly, techniques and operations described herein that refer to the wireless device 700 may be applicable to an apparatus for a wireless device 700 (e.g., a 6 GHz HE STA 505 (or apparatus of), HE STA 504 (or apparatus of), 6 GHz HE AP 503 (or
25 apparatus of), and/or HE AP 502 (or apparatus of)), in some embodiments. In some embodiments, the wireless device 700 is configured to decode and/or encode signals, packets, and/or frames as described herein, e.g., PPDU.

[00107] In some embodiments, the MAC circuitry 706 may be arranged to contend for a wireless medium during a contention period to receive control of
30 the medium for a HE TXOP and encode or decode an HE PPDU. In some embodiments, the MAC circuitry 706 may be arranged to contend for the

wireless medium based on channel contention settings, a transmitting power level, and a clear channel assessment level (e.g., an energy detect level).

[00108] The PHY circuitry 704 may be arranged to transmit signals in accordance with one or more communication standards described herein. For example, the PHY circuitry 704 may be configured to transmit a HE PPDU. The PHY circuitry 704 may include circuitry for modulation/demodulation, upconversion/downconversion, filtering, amplification, etc. In some embodiments, the processing circuitry 708 may include one or more processors. The processing circuitry 708 may be configured to perform functions based on instructions being stored in a RAM or ROM, or based on special purpose circuitry. The processing circuitry 708 may include a processor such as a general purpose processor or special purpose processor. The processing circuitry 708 may implement one or more functions associated with antennas 712, the transceiver 702, the PHY circuitry 704, the MAC circuitry 706, and/or the memory 710. In some embodiments, the processing circuitry 708 may be configured to perform one or more of the functions/operations and/or methods described herein. In some embodiments, the wireless device 700 may be configured to operate on one or more of a 2.4 GHz band and 5 GHz band, and on a 6 GHz band.

[00109] In mmWave technology, communication between a station (e.g., the HE stations 504 of FIG. 5 or wireless device 700) and an access point (e.g., the HE AP 502 of FIG. 5 or wireless device 700) may use associated effective wireless channels that are highly directionally dependent. To accommodate the directionality, beamforming techniques may be utilized to radiate energy in a certain direction with certain beamwidth to communicate between two devices. The directed propagation concentrates transmitted energy toward a target device in order to compensate for significant energy loss in the channel between the two communicating devices. Using directed transmission may extend the range of the millimeter-wave communication versus utilizing the same transmitted energy in omni-directional propagation.

[00110] FIG. 8 illustrates a wireless network 800 in accordance with some embodiments. Illustrated in FIG. 8 is extended service set (ESS) 1 880.1, other networks 870, BSSs 810, ESS 2 850.2, APs 802, management entity 822, Internet 806, and peer-to-peer (P2P) network 840. In some embodiments, the
 5 wireless network 800 represents different networks that are available in a high-density area, e.g., a football stadium or city.

[00111] A management domain may be a portion of the wireless network 800 that is managed by a management entity 822. The ESS 1 880.1 comprises four BSSs 810.1, 810.2, 810.3, and 810.4. The APs 802.1, 802.2, 802.3, and
 10 802.4 are part of their respective BSSs 810.1, 810.2, 810.3, and 810.4. In some embodiments, the APs 802.1, 802.2, 802.3, and 802.4 are coupled to a distribution system (DS) 820 through communication links 808.1, 808.2, 808.3, and 808.4. The DS 820 may be any technology that provides the appropriate services to the ESS 880.1. For example, the DS 820 may be Ethernet cables or
 15 wireless connections. The communication links 808 may be cables or wireless links. The BSSs 810.1, 810.2, 810.3, and 810.4 may include additional APs 802, HE stations 804 (associated with the BSSs 810 or within the BSSs 810), and/or legacy devices 806 (associated with the BSSs 810 or within the BSSs 810). The circles represent a signal range of the BSSs 810, i.e., the one or more APs 802 of
 20 the BSS 810. For example, a HE STA 804 may be outside the signal range of the BSS 810 if a receive signal strength indicator (RSSI) of a beacon frame received by a station 804 may be below -82 dBm (other values be used) outside the circle of the BSS 810. Other measurements of the signals of the BSS 810 may be used.

25 [00112] The APs 802 may be the same or similar as IEEE 802.11ax APs, IEEE 802.11 APs, HE APs 502, and/or 6 GHz HE APs 503. The stations 504 may be the same or similar as IEEE 802.11ax STAs, IEEE 802.11 STAs, HE STAs 504, and/or 6 GHz HE STAs 505. The legacy devices may be the same or similar as legacy devices 506.

30 [00113] The management entity 822 may be a router that routes packets based on destination addresses. The management entity 822 may include

functionality for managing ESS 1 880.1, e.g., a recommended BSS transition threshold and/or other parameters for ESS 1 850.1. In some embodiments, the management entity 822 may not manage parameters of the ESSs.

[00114] The management entity 822 may transmit neighbor information
5 (e.g., 1100, 1300) to one or more of the APs 802.1, 802.2, 802.3, 802.4, and/or stations 804 (not illustrated) that are part of the BSSs 810.1, 810.2, 810.3, and 810.4. In some embodiments, the management entity 822 or different portions of the management entity 822 may reside on different devices, e.g., one of the APs 802, a router, a device in the Internet 806, a server, etc. In some
10 embodiments, the management entity 822 may manage additional networks such as other networks 870. The management entity 822 may receive or coordinate neighbor information.

[00115] The Internet 806 may be an interconnected network with many servers and other communication devices. The APs 802 may each have a basic
15 service set identifier (BSSID). In some embodiments, the BSSIDs are assigned to the APs 802 by the management entity 822. In some embodiments, management entity 822 may generate BSSIDs for APs 802, service set IDs (SSIDs) 832.1, and/or ESSIDs 830 for APs 802 and/or stations 804.

[00116] In some embodiments, the APs 802 generate a BSSID. In some
20 embodiments, the BSSIDs are assigned to the AP 802 by a manufacturer. In some embodiments, the APs 802.1, 802.2, 802.3, and 802.4 each have a BSS color (not illustrated). In some embodiments, the BSS color is assigned to the APs 802.1, 802.2, 802.3, and 802.4 from the management entity 822. In some embodiments, the APs 802.1, 802.2, 802.3, and 802.4 generate a BSS color. In
25 some embodiments the management entity 822 may manage BSS colors between different ESSs 880.

[00117] The BSSs 800.1, BSS 800.2, BSS 800.3, and BSS 800.4 may be part of a planned ESS or managed ESS with an Extended Service Area (ESA)
812. The ESS 880 may be deployed to ensure blanket coverage over the ESA
30 812, e.g., the BSSs 810.1, BSS 810.2, BSS 810.3, and BSS 810.4 may overlap with one another. The ESA 812 may have neighbor reports, e.g., 1100 or 1300,

associated with it that may be used by APs 802 and/or HE stations 804 to determine RSSI thresholds for scanning, transitions, and/or to determine another BSS 810 and/or AP 802 to transition to.

[00118] In accordance with some embodiments, APs 802 that are part of the same ESS 880 may be termed neighbor access points to other APs 802 of the same ESS 880. In some embodiments, neighbor access points may be APs 802 that have signals that overlap. In example embodiments, the management entity 822 and/or APs 802 that are part of the same ESS 880 and/or ESA 812 may share information regarding the neighbor information, e.g., 1100 or 1300. In example embodiments, the management entity 822 and/or HE APs 802 that are part of the same ESS 880 and/or ESA 810 may share information regarding the RSSI and/or neighbor reports.

[00119] In accordance with some embodiments, APs 802 may send information regarding the AP 802 and BSS 800 to neighbor APs 802 or APs 802 that are part of the same ESS 850 or ESA 810. The APs 802 may be configured to operate on different primary channels (e.g., 1112 of FIG. 11), which in some embodiments may be coordinated or facilitated (e.g., via message passing) by the management entity 822 and/or by messaging between neighboring APs 802. Some APs 802 may operate on a 6 GHz band, a 2.4 GHz band, and/or a 5 GHz band.

[00120] BSS 810.8 may not be part of ESS 1 880.1 or ESS 2 880.2. In some embodiments, AP 802.5 may be termed an unmanaged AP 802 because it may not be part of a management entity (e.g., management entity 822). Other networks 870 may be other networks that generate signals. For example, other networks 870 may be a Long-Term Evolution (LTE) license assisted access (LAA). P2P network 840 may be a network of stations 804 where one or more stations 804 are using P2P to communicate and/or one or more of the station 804 are operating (e.g., acting as a GO) as APs (e.g., AP 802). In some embodiments, the stations 804, acting as an AP 802, with at least some of the functionality of the AP 802, may be termed soft APs. ESS 2 880.2 may be similar or the same as ESS 1 880.1. In some embodiments ESS 1 880.1 and ESS 2 880.2 may

communicate with one another, e.g. management entity 822 may communicate with a management entity (not illustrated) of ESS 2 880.2; or, ESS 1 880.1 and ESS 2 880.2 may have a common management entity (not illustrated), e.g., there may be a common management entity reachable by both ESS 1 880.1 and ESS 2
5 880.2, which could be management entity 822 if it was reachable by ESS 2 880.2.

[00121] In some embodiments, the station 804.4 and/or an AP 802 may use the ESS ID 830.1 of ESS 880.1. The APs 802 may transmit neighbor information, e.g., 1100 or 1300, beacon frames, pre-association frames, probe
10 responses, and/or association (or re-association) requests, in accordance with some embodiments. The APs 802 may receive the neighbor information, e.g., 1100 or 1300, from a management entity 822 and then transmit them to stations 804.

[00122] In some embodiments, the AP 802 and/or stations 804 may be
15 configured to determine if a frame is from a wireless device from a different management entity 822 based on the ESS ID 830. The ESS ID 830 may be a service set identifier (SSID), e.g., SSID 832.1, in accordance with some embodiments. In some embodiments, all the APs 502 that are part of a ESS 1 880.1 have the same SSID 832.1. In some embodiments, a field to represent the
20 SSID 832 is between 0 and 32 octets. A length of zero of the SSID field may be used to represent the wildcard SSID. The SSID 832 may be a string of characters, e.g., 32 characters.

[00123] FIG. 9 illustrates a method 900 of 6 GHz association in accordance with some embodiments. Illustrated in FIG. 9 is time 902 along a
25 horizontal axis, bands 940 along a vertical axis, transmitter/receiver 904 along a vertical axis, and operations 950 along the top.

[00124] The bands 940 may be 2.4/5 GHz bands 940.2 and 6 GHz band 940.1, in accordance with some embodiments. In some embodiments, different bands may be used. The transmitter/receiver 904 may be a 6 GHz HE AP 503 or
30 a 6 GHz HE STA 505. The 6 GHz HE AP 503 may be a HE AP 502 configured

to operate on the 6 GHz band. The 6 GHz HE STA 505 may be a HE STA 504 configured to operate on the 6 GHz band.

[00125] The method 900 may begin at operation 952 with the 6 GHz HE AP 503.1 transmitting a neighbor report 920 on the 2.4/5 GHz band 940.2. The
5 neighbor report 920 may include a SSID 930, e.g., SSID 832.1. The neighbor report 920 may be a neighbor report element 1100 or a reduced neighbor report element format 1300, in accordance with some embodiments. The SSID 930 may be part of optional sub-elements field 1116 or optional sub-elements field 1706 as disclosed in conjunction with FIGS. 11 and 13.

10 [00126] The method 900 may continue at operation 952 with the 6 GHz HE STA 505 receiving the neighbor report 920 on the 2.4/5 GHz band 940.2. The neighbor report 920 may be a neighbor report element 1100 or a reduced neighbor report element format 1300, in accordance with some embodiments. The 6 GHz HE STA 505 may determine the SSID 930 from the neighbor report
15 920, e.g., from an optional sub-elements field 1116 or an optional sub-elements field 1706.

[00127] The 6 GHz HE STA 505 may examine fields of the neighbor report 920 to determine if the neighbor report indicates a 6 GHz HE AP 503 with which the 6 GHz HE STA 505 would like to associate with. For example, the 6
20 GHz HE STA 505 may examine the HE field 1218 and 6 GHz HE field 1222 to determine if the AP in the neighbor report supports HE operation and 6 GHz operation. In another example, the 6 GHz HE STA 505 may examine field co-located AP 1506 to determine if the AP in the neighbor report is co-located with the 6 GHz HE AP 503.1 that is transmitting the neighbor report. The 6 GHz HE
25 STA 505 may want a co-located AP if there is currently a good signal (e.g., RSSI value high) from the 6 GHz HE AP 503.1 and may not want a co-located AP if the signal is a bad signal (e.g., RSSI value low) or if the 6 GHz HE AP 503 is moving away from 6 GHz HE AP 503.1.

[00128] The method 900 continues at operation 954 with the 6 GHz HE
30 STA 505 transmitting a probe request 922 on the 6 GHz band 940.1. The probe request 922 includes an SSID 930. In some embodiments, the 6 GHz HE STA

505 is not permitted to set the value of the SSID 930 to a wildcard value, e.g., a length of the SSID 930 being zero. In some embodiments, the probe request 922 may include more than one SSID 930, e.g., in a list element. In some embodiments, the probe request 922 may include a destination address with a value of a broadcast address. In some embodiments, the 6 GHz HE STA 505 may transmit the probe request 922 in response to determining that the 6 GHz AP 503 supports 6 GHz operation. In some embodiments, the 6 GHz HE STA 505 may transmit the probe request 922 in response to determining that the ESS indicated by the SSID 930 supports 6 GHz operation. In some embodiments, the 6 GHz HE STA 505 may transmit the probe request 922 in response to determining that at least one 6 GHz AP 503 indicated by the SSID 930 supports 6 GHz operation.

[00129] The method 900 continues at operation 954 with the 6 GHz HE AP 503.2 receiving the probe request 922. The 6 GHz HE AP 503.2 may compare the SSID 930 to an SSID of the 6 GHz HE AP 503.2, e.g., as disclosed in conjunction with FIG. 8. The 6 GHz HE AP 503.2 may determine that the SSID of the 6 GHz HE AP 503.2 matches the SSID 930 of probe request 922.

[00130] The method 900 may continue at operation 956 with the 6 GHz HE AP 503.2 transmitting a probe response 924 on the 6 GHz band 940.1. The probe response 924 may include SSID 930 and BSSID 932. The SSID 930 may in some embodiments not be included in the probe response 924. The BSSID 932 may be an identifier of the 6 GHz HE AP 503.2 that may be used by the 6 GHz HE STA 505 to associate with the 6 GHz HE AP 503.2. The probe response 924 may contain information regarding the 6 GHz HE AP 503.2, e.g., Table 9-34 of IEEE Std 802.11™-2016 as amended by IEEE P802.11ax/D2.3, April 2018, and which may include sub-elements 6 GHz capabilities (sub-element ID to be determined), and 6 GHz operation sub-element (sub-element ID to be determined).

[00131] The method 900 may continue at operation 956 with the 6 GHz HE STA 505 receiving the probe response 924 on the 6 GHz band 940.1. The 6 GHz HE STA 505 may determine based on the probe response 924 that the 6

GHz HE STA 595 will associate with the 6 GHz HE AP 503.2. In some embodiments, the 6 GHz HE STA 595 examines information in the probe response 924 and determines whether to request to associate with the 6 GHz HE AP 503.2 based on the information, e.g., security, services available, etc. The determination may further be based on a signal strength of the probe response 924.

[00132] The method 900 may continue at operation 958 with the 6 GHz HE STA 505 transmitting an association request 926, which may in some embodiments be a re-association request. The association request 926 may include a destination address of the 6 GHz HE AP 503.2, e.g., BSSID 932.

[00133] The method 900 may continue with additional operations with the 6 GHz HE AP 503.2 responding with an association response, which may include an association ID (AID) for the 6 GHz HE STA 505. The 6 GHz HE STA 505 may then be associated with the 6 GHz HE AP 503 and request and/or receive various services from the 6 GHz HE AP 503.2. In some embodiments, the neighbor report 920, probe response 924 and/or association response (not illustrated) may include 6 GHz operation fields 1800. For example, minimum bandwidth field 1802 may indicate a minimum bandwidth for communication on the 6 GHz band. In another example, PPDU types field 1804 may indicate permitted types of PPDU. The 6 GHz HE STA 505 may be configured to operate in accordance with the restrictions/parameters in the 6 GHz operation fields 1800.

[00134] The method 900 may be performed by a 6 GHz HE STA 505, a 6 GHz HE AP 503, an apparatus of 6 GHz HE STA 505 and/or an apparatus of 6 GHz HE AP 503, in accordance with some embodiments. The method 900 may include one or more additional operations. The method 900 may be performed in a different order in accordance with some embodiments. The method 900 may include additional operations in accordance with some embodiments. Between the operations of method 900, the 6 GHz HE APs 503 and/or 6 GHz HE STA 505 may wait an interframe space between performing a next operation, e.g., a short interframe space.

[00135] In some embodiments, 6 GHz HE STA 505 may be configured to perform in accordance with 11.1.4.3.2 Active scanning procedure for a non-DMG STA of IEEE Std 802.11™-2016 with the modification disclosed in IEEE P802.11ax/D2.3, with the addition that the 6 GHz HE STA 505 is not permitted
5 to use a SSID wildcard in the probe request.

[00136] In some embodiments, 6 GHz HE STA 505 may be configured to perform in accordance with 11.1.4 Acquiring synchronization, scanning of IEEE Std 802.11™-2016 with the modification disclosed in IEEE 802.11ax/D2.3, with the addition that the 6 GHz HE STA 505 is not permitted to use a SSID wildcard
10 in the probe request, and the 6 GHz HE STA 505 when operating in the 6GHz band (see IEEE 802.11ax/D2.3 28.3.22.2 Channel allocation in the 6 GHz band), a STA (e.g., 6 GHz HE STA 505) shall not scan for scans for a BSS whose AP does not support the SSID List element, or for a BSS for which AP support of the SSID List element is unknown.

[00137] In some embodiments, the 6 GHz band 940.1 may be used more efficiently by not permitting the 6 GHz HE STA 505 to use the wildcard SSID in probe requests. In some embodiments, the 6 GHz band 940.1 may be used more efficiently by the 6 GHz HE STA 505 receiving information, e.g., a neighbor report 920, regarding a new AP, e.g., on the 2.4/5 GHz band and then associating
15 with the new AP, e.g., 6 GHz HE AP 503.2 on the 6 GHz band 940.1.

[00138] In some embodiments, the 6 GHz band 940.1 may be used more efficiently by allowing the 6 GHz HE STA 505 only to be able to associate with a 6 GHz HE AP 503.2 with a re-association request. The re-association request may move a current associate from 6 GHz HE AP 503.1 to 6 GHz HE AP 503.2,
20 when 6 GHz HE AP 503.1 and 6 GHz HE AP 503.2 are part of a same ESS, e.g., 880.1.

[00139] In some embodiments, the neighbor report 920 includes 6 GHz operation fields 1800 for 6 GHz HE AP 503.2. The 6 GHz HE STA 505 may determine a next beacon time for 6 GHz HE AP 503.2 based on AP TBTT offset field 1702, beacon interval field 1704, and a TBTT of 6 GHz HE AP 503.1. The
30 AP TBTT offset field 1702 may be added to the last TBTT of 6 GHz HE AP

503.1 (which may be rounded down). The beacon interval field 1704 indicates an interval of the beacons for 6 GHz HE AP 503.2. For example, the next beacon time for 6 GHz HE AP 503.2 plus the value of the beacon interval field 1704 may indicate a second or next beacon after the next beacon time. The 6 GHz HE STA 505 may wait for a beacon from 6 GHz HE AP 503.2 (which may be transmitted on the 2.4/5 GHz band 940.2 or the 6 GHz band 940.1). The 6 GHz HE STA 505 may then determine based on information in the beacon, e.g., 6 GHz HE field 1222, HE field 1218, whether to transmit an association request 926. The beacon may include the BSSID 932 of 6 GHz HE AP 503.2. The 6 GHz HE STA 505 may transmit the association request 926 (which may be transmitted on the 2.4/5 GHz band 940.2 or the 6 GHz band 940.1) without first transmitting a probe request 922. In this way, the 6 GHz HE STA 505 may avoid transmitting the probe request 922.

[00140] FIG. 10 illustrates a method 1000 of 6 GHz association in accordance with some embodiments. Illustrated in FIG. 10 is time 1002 along a horizontal axis, bands 1040 along a vertical axis, transmitter/receiver 1004 along a vertical axis, and operations 1050 along the top.

[00141] The bands 1040 may be 2.4/5 GHz bands 940.2 and 6 GHz band 1040.1, in accordance with some embodiments. In some embodiments, different bands may be used. The transmitter/receiver 1004 may be a 6 GHz HE AP 503 or a 6 GHz HE STA 505. The 6 GHz HE AP 503 may be a HE AP 502 configured to operate on the 6 GHz band. The 6 GHz HE STA 505 may be a HE STA 504 configured to operate on the 6 GHz band.

[00142] The method 1000 may begin at operation 1052 with the 6 GHz HE AP 503.1 transmitting a neighbor report 1020 on the 2.4/5 GHz band 1040.2. The neighbor report 1020 may include a SSID 1030, e.g., SSID 832.1, and/or a BSSID 1032, e.g., 1106. The neighbor report 1020 may be a neighbor report element 1100 or a reduced neighbor report element format 1300, in accordance with some embodiments. The SSID 1030 may be part of optional sub-elements field 1116 or optional sub-elements field 1706 as disclosed in conjunction with

FIGS. 11 and 13. In some embodiments, the SSID 1030 is not included in the neighbor report 1020.

[00143] The method 1000 may continue at operation 1052 with the 6 GHz HE STA 505 receiving the neighbor report 1020 on the 2.4/5 GHz band 1040.2.

- 5 The neighbor report 1020 may be a neighbor report element 1100 or a reduced neighbor report element format 1300, in accordance with some embodiments. The 6 GHz HE STA 505 may determine the SSID 1030 from the neighbor report 1020, e.g., from an optional sub-elements field 1116 or an optional sub-elements field 1706. The 6 GHz HE STA 505 may determine the BSSID 1032 from the
10 neighbor report 1020.

- [00144] The 6 GHz HE STA 505 may examine fields of the neighbor report 920 to determine if the neighbor report indicates a 6 GHz HE AP 503 with which the 6 GHz HE STA 505 would like to associate with. For example, the 6 GHz HE STA 505 may examine the HE field 1218 and 6 GHz HE field 1222 to
15 determine if the AP in the neighbor report supports HE operation and 6 GHz operation. In another example, the 6 GHz HE STA 505 may examine field co-located AP 1506 to determine if the AP in the neighbor report is co-located with the 6 GHz HE AP 503.1 that is transmitting the neighbor report. The 6 GHz HE STA 505 may want a co-located AP if there is currently a good signal (e.g.,
20 RSSI value high) from the 6 GHz HE AP 503.1 and may not want a co-located AP if the signal is a bad signal (e.g., RSSI value low) or if the 6 GHz HE STA 505 is moving away from 6 GHz HE AP 503.1.

- [00145] The method 1000 continues at operation 1054 with the 6 GHz HE STA 505 transmitting a probe request 1022 on the 2.4/5 GHz band 940.2. The
25 probe request 1022 includes an SSID 1030 and/or BSSID 1032. In some embodiments, the 6 GHz HE STA 505 is not permitted to set the value of the SSID 1030 to a wildcard value, e.g., a length of the SSID 1030 being zero. In some embodiments, the probe request 1022 may include more than one SSID 1030, e.g., in a list element. In some embodiments, the probe request 1022 does
30 not include the SSID 1030 but does include the BSSID 1032. In some embodiments, the probe request 1022 may include a destination address with a

value of a broadcast address. In some embodiments, the 6 GHz HE STA 505 may transmit the probe request 1022 in response to determining that the 6 GHz AP 503 supports 6 GHz operation. In some embodiments, the 6 GHz HE STA 505 may transmit the probe request 1022 in response to determining that the ESS indicated by the SSID 1030 supports 6 GHz operation. In some embodiments, the 6 GHz HE STA 505 may transmit the probe request 1022 in response to determining that at least one 6 GHz AP 503 indicated by the SSID 1030 supports 6 GHz operation.

[00146] The method 1000 continues at operation 1054 with the 6 GHz HE AP 503.2 receiving the probe request 1022. The 6 GHz HE AP 503.2 may compare the SSID 1030 to an SSID of the 6 GHz HE AP 503.2, e.g., as disclosed in conjunction with FIG. 8. The 6 GHz HE AP 503.2 may determine that the SSID of the 6 GHz HE AP 503.2 matches the SSID 1030 of probe request 922. In some embodiments, the 6 GHz HE AP 503.2 may determine that the BSSID 1032 matches a BSSID of the 6 GHz HE AP 503.2.

[00147] The method 1000 may continue at operation 1056 with the 6 GHz HE AP 503.2 transmitting a probe response 924 on the 2.4/5 GHz band 940.2. The probe response 1024 may include SSID 1030 and BSSID 1032. The SSID 1030 may, in some embodiments, not be included in the probe response 1024. The BSSID 1032 may be an identifier of the 6 GHz HE AP 503.2 that may be used by the 6 GHz HE STA 505 to associate with the 6 GHz HE AP 503.2. The probe response 1024 may contain information regarding the 6 GHz HE AP 503.2, e.g., Table 9-34 of IEEE Std 802.11™-2016 as amended by IEEE P802.11ax/D2.3, April 2018, and which may include sub-elements 6 GHz capabilities (sub-element ID to be determined), and 6 GHz operation sub-element (sub-element ID to be determined).

[00148] The method 1000 may continue at operation 1056 with the 6 GHz HE STA 505 receiving the probe response 1024 on the 2.4/5 GHz band 1040.1. The 6 GHz HE STA 505 may determine based on the probe response 1024 that the 6 GHz HE STA 595 will associate with the 6 GHz HE AP 503.2. In some embodiments, the 6 GHz HE STA 595 examines information in the probe

response 1024 and determine whether to request to associate with the 6 GHz HE AP 503.2 based on the information, e.g., security, services available, etc.

[00149] The method 1000 may continue at operation 1058 with the 6 GHz HE STA 505 transmitting an association request 1026, which may in some
5 embodiments be a re-association request, on the 2.4/5 GHz band 1040.2. The association request 1026 may include a destination address of the 6 GHz HE AP 503.2, e.g., BSSID 1032. In some embodiments, the 6 GHz HE STA 505 transmits the association request 1026, which may in some embodiments be a re-association request, on the 6 GHz band 1040.1.

10 [00150] The method 1000 may continue with the 6 GHz HE AP 503.2 transmitting an association response 1028 on the 6 GHz Band 1040.1. The association response 1028 may include an association ID (AID) for the 6 GHz HE STA 505. In some embodiments, the association response 1028 is transmitted on the 2.4/5 GHz band 1040.2 with operations after association being
15 performed on the 6 GHz band 1040.1. In some embodiments, the neighbor report 1020, probe response 1024 and/or association response 1034 may include 6 GHz operation fields 1800. For example, minimum bandwidth field 1802 may indicate a minimum bandwidth for communication on the 6 GHz band. In another example, PPDU types field 1804 may indicate permitted types of
20 PPDUs. The 6 GHz HE STA 505 may be configured to operate in accordance with the restrictions/parameters in the 6 GHz operation fields 1800.

[00151] The method 1000 may continue with additional operations, where the 6 GHz HE AP 503 and request and/or receive various services from the 6 GHz HE AP 503.2. In some embodiments, the additional operations are
25 performed on the 6 GHz band 1040.1.

[00152] The method 1000 may be performed by a 6 GHz HE STA 505, a 6 GHz HE AP 503, an apparatus of 6 GHz HE STA 505 and/or an apparatus of 6 GHz HE AP 503, in accordance with some embodiments. The method 1000 may include one or more additional operations. The method 1000 may be
30 performed in a different order in accordance with some embodiments. The method 1000 may include additional operations in accordance with some

embodiments. Between the operations of method 1000, the 6 GHz HE APs 503 and/or 6 GHz HE STA 505 may wait an interframe space between performing a next operation, e.g., a short interframe space.

[00153] In some embodiments, the neighbor report 1020 includes 6 GHz operation fields 1800 for 6 GHz HE AP 503.2. The 6 GHz HE STA 505 may determine a next beacon time for 6 GHz HE AP 503.2 based on AP TBTT offset field 1702, beacon interval field 1704, and a TBTT of 6 GHz HE AP 503.1. The AP TBTT offset field 1702 may be added to the last TBTT of 6 GHz HE AP 503.1 (which may be rounded down). The beacon interval field 1704 indicates an interval of the beacons for 6 GHz HE AP 503.2. For example, the next beacon time for 6 GHz HE AP 503.2 plus the value of the beacon interval field 1704 may indicate a second or next beacon after the next beacon time. The 6 GHz HE STA 505 may wait for a beacon from 6 GHz HE AP 503.2 (which may be transmitted on the 2.4/5 GHz band 1040.2 or the 6 GHz band 1040.1). The 6 GHz HE STA 505 may then determine based on information in the beacon, e.g., 6 GHz HE field 1222, HE field 1218, whether to transmit an association request 1026. The beacon may include the BSSID 1032 of 6 GHz HE AP 503.2. The 6 GHz HE STA 505 may transmit the association request 1026 (which may be transmitted on the 2.4/5 GHz band 1040.2 or the 6 GHz band 1040.1) without first transmitting a probe request 1022. In this way, the 6 GHz HE STA 505 may avoid transmitting the probe request 1022.

[00154] In some embodiments, 6 GHz HE STA 505 may be configured to perform in accordance with 11.1.4.3.2 Active scanning procedure for a non-DMG STA of IEEE Std 802.11™-2016 with the modification disclosed in a IEEE P802.11ax/D2.3, with the addition that the 6 GHz HE STA 505 is not permitted to use a SSID wildcard in the probe request.

[00155] In some embodiments, 6 GHz HE STA 505 may be configured to perform in accordance with 11.1.4 Acquiring synchronization, scanning of IEEE Std 802.11™-2016 with the modification disclosed in IEEE P802.11ax/D2.3, with the addition that the 6 GHz HE STA 505 is not permitted to use a SSID wildcard in the probe request, and the 6 GHz HE STA 505 when operating in the

6GHz band (see 28.3.22.2 Channel allocation in the 6 GHz band), a STA shall not scan for scans for a BSS whose AP does not support the SSID List element, or for a BSS for which AP support of the SSID List element is unknown.

[00156] In some embodiments, the 6 GHz band 1040.1 may be used more efficiently by not permitting the 6 GHz HE STA 505 to use the wildcard SSID in probe requests. In some embodiments, the 6 GHz band 1040.1 may be used more efficiently by the 6 GHz HE STA 505 receiving information, e.g., a neighbor report 1020, regarding a new AP, e.g., on the 2.4/5 GHz band and sending probe requests 1022 on the 2.4/5 GHz band 1040.2.

10 [00157] In some embodiments, the 6 GHz band 1040.1 may be used more efficiently by the 6 GHz HE STA 505 only be able to associate with a 6 GHz HE AP 503.2 with a re-association request. The re-association request may move a current associate from 6 GHz HE AP 503.1 to 6 GHz HE AP 503.2, when 6 GHz HE AP 503.1 and 6 GHz HE AP 503.2 are part of a same ESS, e.g., 880.1.

15 [00158] In some embodiments, the neighbor report 1020 may include information regarding a TBTT, e.g., 1700. The 6 GHz HE STA 505 may determine whether neighbor AP TBTT offset is a first format (e.g., 1600) or a second format (e.g., 1700). The 6 GHz HE STA 505 may then tune into the 6 GHz band 1040.1 and wait for a beacon from the 6 GHz HE AP 503.2. The time to wait may be determined based on the disclosure of FIGS. 16 and 17. The 6 GHz HE STA 505 may then decode a beacon from 6 GHz HE AP 503.2 and determine based on information in the beacon whether or not to transmit an association request.

25 [00159] FIG. 11 illustrates a neighbor report element 1100 in accordance with some embodiments. Illustrated in FIG. 11 is an element ID field 1102, a length field 1104, a BSSID field 1106, a BSSID information field 1108, an operating class field 1110, a channel number field 1112, a physical (PHY) type field 1114, an optional sub-elements field 1116, and octets 1118.

[00160] In some embodiments, the element ID field 1102 is an element ID that identifies the neighbor report element 1100. In some embodiments, the length field 1104 indicates the length in octets of the neighbor report element

1100 after the length field 1104. In some embodiments, the BSSID field 1106 is the BSSID of the BSS (e.g., a BSSID of the HE AP 502) being reported.

[00161] In some embodiments, the BSSID information field 1108 includes fields that can be used to determine neighbor service set transition
5 candidates. BSSID information field 1200 is an example of BSSID information field 1108.

[00162] In some embodiments, the operating class field 1110 indicates the channel set of the AP indicated by the BSSID field 1106. In some embodiments, the channel number field 1112 indicates the last known primary channel of the
10 AP indicated by the BSSID field 1106. In some embodiments, the physical (PHY) type field 1114 indicates a PHY type of the AP indicated by the BSSID field 1106.

[00163] In some embodiments, the optional sub-elements field 1116 includes zero or more sub-elements. For example, the sub-elements field 1116
15 may include zero or more of HT capabilities subelement (subelement ID 45), HT operation subelement (subelement ID 61), VHT capabilities (subelement ID 191), VHT operation (subelement ID 192), HE capabilities (subelement ID to be determined), HE operation subelement (subelement ID to be determined), 6 GHz capabilities (subelement ID to be determined), and 6 GHz operation subelement
20 (subelement ID to be determined). In some embodiments, the elements without subelement IDs assigned may be assigned element IDs with an element ID extension. The octets 1118 may indicate a number of octets of the fields, in accordance with some embodiments. In some embodiments, neighbor report element 1100 may include one or more additional fields. In some embodiments,
25 neighbor report element 1100 may not include all the fields illustrated in FIG. 11.

[00164] FIG. 12 illustrates basic service set (BSS) identification (ID) information field 1200 in accordance with some embodiments. Illustrated in
FIG. 12 is AP reachability field 1202, security field 1204, key scope field 1206,
30 capabilities field 1208, mobility domain field 1210, high throughput field 1212, very-high throughput field 1214, fine-timing measurement (FTM) field 1216,

HE field 1218, HE ER BSS field 1220, and reserved 1224. In some embodiments, BSSID information field 1200 is an example of BSSID information field 1108.

[00165] In some embodiments, the AP reachability field 1202 indicates whether the AP indicated by the BSSID information field 1200 is reachable by the HE STA 504 that requested the neighbor report. In some embodiments, the security field 1204 indicates whether the security provided by the AP identified by the BSSID information field 1200 provides the same security as the AP the HE STA 504 is receiving the BSSID information field 1200 from. In some embodiments, the key scope field 1206 may indicate whether the HE AP 50 has the same authenticator as the AP sending the BSSID information field 1200.

[00166] In some embodiments, the capabilities field 1208 may include capability information for the AP indicated by this BSSID. In some embodiments, the mobility domain field 1210 indicates that the AP indicated by the BSSID information field 1200 includes a mobility domain element (MDE) in its beacon frames, which may be identical to the MDEs that the AP that sent the BSSID information field 1200 sends.

[00167] In some embodiments, the HT field 1212 indicates that the AP indicated by the BSSID information field 1200 is an HT AP that includes HT capabilities elements in its beacons and that the HT capabilities element is the same as the HT capabilities element is the same advertised by the AP sending the BSSID information field 1200.

[00168] In some embodiments, the VHT field 1214 indicates that the AP indicated by the BSSID information field 1200 is an HT AP that includes VHT capabilities elements in its beacons and that the HT capabilities element is the same as the HT capabilities element is the same advertised by the AP sending the BSSID information field 1200. In some embodiments, the FTM field 1216 indicates that the AP indicated by the BSSID is an AP that set the FTM responder field of the extended capabilities element to 1.

[00169] In some embodiments, the HE field 1218, is set to 1 to indicate that the AP represented by the BSSID information field 1200 is an HE AP 504

and that the HE Capabilities element (or HE Operation element), if included as a subelement in the report, is identical in content to the HE Capabilities element (or HE Operation element) included in the beacon frame of the AP represented by the BSSID Beacon frame. Otherwise the HE field 1218 is set to 0, in accordance with some embodiments.

[00170] In some embodiments, the HE extended range (ER) BSS field 1220 is set to one to indicate that the BSS indicated by the BSSID 1106 supports ER. In some embodiments, the 6 GHz HE field 1222 is set to 1 to indicate that the AP represented by this BSSID information field 1200 is an HE 6G AP and that the HE 6G capabilities subelement and/or HE 6G Operation subelement, if included as a subelement in the report, is identical in content to the HE 6G Capabilities subelement and/or HE 6G Operation subelement included in the beacon frame of the HE 6G AP indicated by the BSSID information field 1200. Otherwise the 6G HE subfield is set to 0, in accordance with some embodiments.

[00171] In some embodiments, the reserved field 1224 includes one or more bits that are reserved for different and/or future use. In some embodiments, one or more of the fields illustrated in FIG. 12 may be option. In some embodiments, one or more additional fields not illustrated in FIG. 12 may be included in the BSSID 1200. The bits 1226 indicates a number of bits of the fields in accordance with some embodiments. In some embodiments, BSSID information field 1200 may include one or more additional fields. In some embodiments, BSSID information field 1200 may not include all the fields illustrated in FIG. 12.

[00172] FIG. 13 illustrates a reduced neighbor report element 1300 in accordance with some embodiments. Illustrated in FIG. 13 is element ID field 1302, length field 1304, neighbor AP information fields 1306, and octets 1308.

[00173] In some embodiments, the element ID field 1302 indicates an element ID (which may include an element ID extension) that is used to identify the reduced neighbor report element format 1300 element. In some embodiments, the length field 1304 may indicate the number of octets following the length field 1304.

[00174] In some embodiments, the neighbor AP information fields 1306 comprises one or more neighbor AP information fields, e.g., neighbor AP information field in accordance with a neighbor AP information field format 1400. In some embodiments, the octets 1308 indicates the number of octets of the fields of the reduced neighbor report element format 1300. In some
5 embodiments, a reduced neighbor report element 1300 may include one or more additional fields. In some embodiments, a reduced neighbor report element 1300 may not include all the fields illustrated in FIG. 13.

[00175] FIG. 14 illustrates a neighbor AP information field format 1400 in accordance with some embodiments. Illustrated in FIG. 14 is TBTT
10 information header field 1402, operating class field 1404, channel number field 1406, TBTT information set field 1408, and octets 1410. In some embodiments, neighbor AP information field format 1400 may be an example of a neighbor AP information fields 1306.

[00176] In some embodiments, the TBTT information header field 1402 may include information regarding the TBTT. TBTT information header
15 subfield 1500 is an example of TBTT information header field 1402. In some embodiments, the operating class field 1404 indicates a channel starting frequency that, together with the channel number field, indicates the primary
20 channel of the BSSs of the APs indicated in the neighbor AP information field format 1400. In some embodiments, the channel number field 1406 indicates the last known primary channel of the APs indicated in the neighbor AP information field format 1400.

[00177] In some embodiments, the TBTT information set field 1408 may
25 include one or more TBTT information fields. For example, TBTT information field 1700 is an example of a TBTT information field of the TBTT information set field 1408. In some embodiments, the octets 1410 indicates a number of octets of the fields of the neighbor AP information field format 1400. In some
30 embodiments, a neighbor AP information field format 1400 may include one or more additional fields. In some embodiments, a neighbor AP information field format 1400 may not include all the fields illustrated in FIG. 14.

[00178] FIG. 15 illustrates a target beacon transmit time (TBTT) information header subfield 1500 in accordance with some embodiments. Illustrated FIG. 15 is TBTT information field type 1502, filtered neighbor AP field 1504, co-located AP field 1506, TBTT information count field 1508, TBTT information length 1510, and bits 1512. In some embodiments, TBTT information header subfield 1500 may be an embodiment of TBTT information set 1408.

[00179] In some embodiments, the TBTT information field type 1502 defines the structure of the TBTT information field (e.g., 1400). In some embodiments, the value of the TBTT information field type 1502 indicates a format of the TBTT information fields, e.g., a value of zero may indicate a format of neighbor AP TBTT offset field 1600, and a value of one may indicate a format of neighbor AP TBTT offset field 1700.

[00180] In some embodiments, the filtered neighbor AP field 1504 indicates whether the SSID of APs in this neighbor AP information field (e.g., 1400) matches the specific SSID in the Probe request frame.

[00181] In some embodiments, the co-located AP field 1506 indicates if the AP in the Neighbor AP Information field is co-located with the AP that sends the reduced neighbor report element. In some embodiments, a value of one of the co-located AP field 1506 indicates that the AP in the Neighbor AP information field is co-located with the AP that sends the reduced neighbor report element.

[00182] In some embodiments, the TBTT information count field 1508 is four bits in length and contains the number of TBTT Information fields that are included in the Neighbor AP Information field, minus one. A value of zero indicates one TBTT Information field is present.

[00183] In some embodiments, the TBTT information length 1510 indicates the length in octets of each TBTT Information field that is included in the Neighbor AP Information field. In some embodiments, the bits 1512 indicates a number of bits of the fields of the TBTT information header subfield 1500. In some embodiments, a TBTT information header subfield 1500 may

include one or more additional fields. In some embodiments, a TBTT information header subfield 1500 may not include all the fields illustrated in FIG. 15.

[00184] FIG. 16 illustrates a TBTT information field 1600 in accordance with some embodiments. Illustrated in FIG. 16 is neighbor AP TBTT offset field 1602. The neighbor AP TBTT offset field 1602 may indicate the offset in time units (TUs), rounded down to the nearest TU, to the next TBTT of an AP from the immediately prior TBTT of the AP that transmits the TBTT information field 1600. A value 254 indicates an offset of 254 TUs or higher, in accordance with some embodiments. The value 255 indicates an unknown offset value, in accordance with some embodiments. In some embodiments, the TBTT information field type 1502 defines the structure of the TBTT information field (e.g., 1400). In some embodiments, the value of the TBTT information field type 1502 indicates a format of the TBTT information fields, e.g., a value of zero may indicate a format of neighbor AP TBTT offset field 1600, and a value of one may indicate a format of neighbor AP TBTT offset field 1700. The octets 1604 indicates that neighbor AP TBTT offset field 1602 is one octet.

[00185] FIG. 17 illustrates a TBTT information field 1700 in accordance with some embodiments. Illustrated in FIG. 17 is neighbor AP TBTT offset field 1702, beacon interval field 1704, optional subelements field 1706, and octets 1708.

[00186] In some embodiments, the AP TBTT offset field 1702 indicates the offset in TUs, rounded down to nearest TU, to the next TBTT of an AP from the immediately prior TBTT of the AP that transmits the TBTT information field 1700. The value 254 indicates an offset of 254 TUs or higher, in accordance with some embodiments. The value 255 indicates an unknown offset value, in accordance with some embodiments. In some embodiments, the beacon interval field 1704 indicates the beacon interval of the AP where the unit of the Beacon Interval field 1704 is TU. In some embodiments, the beacon interval field 1704 may indicate a value greater than 100 ms, e.g., 300 ms or more.

[00187] In some embodiments, the optional subelements field 1706 contains zero or more subelements. The subelement format and ordering of subelements may be as defined in section 9.4.3 of IEEE Std 802.11™-2016. For example, the sub-elements field 1706 may include zero or more of HT capabilities subelement (subelement ID 45), HT operation subelement (subelement ID 61), VHT capabilities (subelement ID 191), VHT operation (subelement ID 192), HE capabilities (subelement ID to be determined), HE operation subelement (subelement ID to be determined), 6 GHz capabilities (subelement ID to be determined), and 6 GHz operation subelement (subelement ID to be determined). In some embodiments, the elements without subelement IDs assigned may be assigned element IDs with an element ID extension.

[00188] In some embodiments, the value of the TBTT information field type 1502 indicates a format of the TBTT information fields, e.g., a value of zero may indicate a format of neighbor AP TBTT offset field 1600, and a value of one may indicate a format of neighbor AP TBTT offset field 1700. The octets 1708 indicates a number of octets for the fields of FIG. 17. In some embodiments, a TBTT information field 1700 may include one or more additional fields. In some embodiments, TBTT information field 1700 may not include all the fields illustrated in FIG. 17.

[00189] FIG. 18 illustrates 6 GHz operation fields 1800 in accordance with some embodiments. Illustrated in FIG. 18 is minimum bandwidth field 1802 and PPDU types field 1804. The minimum bandwidth field 1802 may indicate a minimum bandwidth (e.g., greater than 20 MHz) for communication on the 6 GHz band. In some embodiments, the minimum bandwidth field 1802 may indicate a primary channel to use that may be greater than 20 MHz. In some embodiments, the minimum bandwidth field 1802 may indicate a channel number that indicates a channel bandwidth. In some embodiments, the fields for 6 GHz may be an information element that may be included in the neighbor report element 1100 or the neighbor AP information field format 1400.

[00190] The PPDU types field 1804 may indicate permitted types of PPDU. PPDU types field 1804 may be a bitmap with a type of PPDU

corresponding to one of the bits. For example, the types of PPDU may be a HE SU PPDU, HE MU PPDU, HE trigger based (TB) PPDU, and/or HE SU EX (extended) PPDU. In some embodiments, an indication of whether association requests and the use of SSID wildcards may be included in the 6 GHz operation fields 1800.

[00191] In some embodiments, the channel number field 1112, 1406, in the neighbor report element 1100 or the neighbor AP information field format 1400, respectively, may be used to indicate a minimum channel width or a channel with a width, which may be the primary channel. In some

10 embodiments, reserved bits (e.g., reserved field 1224) are used to indicate a minimum channel width and/or a channel with a width, which may be the primary channel.

[00192] FIG. 19 illustrates a method 1900 of 6 GHz association in accordance with some embodiments. The method 1900 may begin at operation

15 1902 with decoding a frame comprising a SSID and an indication of whether 6 GHz HE operation is supported, wherein the frame is received on a 2.4 GHz band or a 5 GHz band. For example, the frame may be neighbor report 920 that include SSID 930 or neighbor report 1020 that includes SSID 1030. In some embodiments, operation 1902 is optional and the SSID may be decoded from a

20 frame on the 6 GHz band, e.g., the 6 GHz HE AP 503 of FIGS. 9 and 10 may transmit a beacon that is decoded by the 6 GHz HE STA 505 of FIGS. 9 and 10. The SSID may be a BSSID 1106. The SSID may be determined based on one or more of the following: an optional sub-elements field 1116, a neighbor AP information fields 1306, optional sub-elements 1706, SSID 930, SSID 1030,

25 neighbor report 920, neighbor report 1020, and/or another frame such as a beacon. The 6 GHz HE operation supported may be determined from the neighbor report 920, neighbor report 1020, and/or 6 GHz HE field 1222.

[00193] The method 1900 may continue at operation 1904 with in response to the indication indicating that 6 GHz HE operation is supported,

30 encode a probe request frame to include a SSID field set to the SSID and encode the probe request frame to include a destination address field set to a broadcast

destination address. For example, 6 GHz HE STA 505 of FIGS. 9 and 10 may encode probe request 922, 1022 to include SSID 1030 and a destination address with a value of a broadcast address.

[00194] The method 1900 may continue at operation 1906 with generating
5 signaling to transmit the probe request frame on a subchannel within a 6 GHz band. For example, an apparatus of 6 GHz HE STA 505 of FIGS. 9 and 10 may generate signaling to transmit the probe request frame 922, 1022.

[00195] The method 1900 may continue at operation 1908 with decoding
10 a probe response from a HE AP, the HE AP configured to operate in the 6 GHz band, and the probe response received within the 6 GHz band, the probe response comprising a BSSID of the HE AP, wherein the HE AP is a member of an ESS with the SSID. For example, 6 GHz HE AP 503 may generate probe response 924 with BSSID 932 of the 6 GHz HE AP 503. The 6 GHz HE AP 503 may transmit the probe response 924 on a subchannel within the 6 GHz band
15 940.1.

[00196] The method 1900 may be performed by a 6 GHz HE STA 505, a
6 GHz HE AP 503, an apparatus of 6 GHz HE STA 505 and/or an apparatus of 6 GHz HE AP 503, in accordance with some embodiments. The method 1900 may include one or more additional operations. The method 1900 may be
20 performed in a different order in accordance with some embodiments. The method 1900 may include additional operations in accordance with some embodiments.

[00197] FIG. 20 illustrates a method 2000 of 6 GHz association in
accordance with some embodiments. The method 2000 begins at operation 2002
25 with decoding a probe request frame, the probe request comprising a service set identification SSID field and a destination address field with a value of a broadcast destination address. For example, the 6 GHz AP 503.2 of FIGS. 9 and 10 may decode probe request 922, 1022, with SSID 930, 1030, respectively, where the probe requests 922, 1022 may include a destination address field with
30 a value of a broadcast destination address.

[00198] The method 2000 may continue at operation 2004 with in response to a value of the SSID field being a SSID of an ESS of the 6 GHz HE AP, encoding a probe response, the probe response comprising a BSSID of the 6 GHz HE AP, and generating signaling to transmit the probe response frame on a subchannel within a 6 GHz band. For example, 6 GHz HE AP 503.2 of FIGS. 9 and 10 may respond to the probe request with SSID 930, 1030 that is equal to an SSID of the 6 GHz HE AP 503.2, which may indicate a same ESS. The response may be a probe response 924, 1024 that may include a BSSID 932, 1032 of the 6 GHz HE AP 503.2. An apparatus of the 6 GHz HE AP 503.2 may generate signaling to cause the 6 GHz HE AP 503.2 to transmit the probe response 924, 1024.

[00199] The method 2000 may be performed by a 6 GHz HE STA 505, a 6 GHz HE AP 503, an apparatus of 6 GHz HE STA 505 and/or an apparatus of 6 GHz HE AP 503, in accordance with some embodiments. The method 2000 may include one or more additional operations. The method 2000 may be performed in a different order in accordance with some embodiments. The method 2000 may include additional operations in accordance with some embodiments.

[00200] The following examples pertain to further embodiments.

Example 1 is an apparatus of a high-efficiency (HE) station (STA), the HE STA configured to operate in a 6 GHz band, the apparatus including: memory; and processing circuitry coupled to the memory, the processing circuitry configured to: decode a frame including a service set identification (SSID) and an indication of whether 6 GHz HE operation is supported, where the frame is received on a 2.4 Hz band or a 5 GHz band; in response to the indication indicating that 6 GHz HE operation is supported, encode a probe request frame to include a SSID field set to the SSID and encode the probe request frame to include a destination address field set to a broadcast destination address, generate signaling to transmit the probe request frame on a subchannel within the 6 GHz band, and decode a probe response from a HE access point (AP), the HE AP configured to operate in the 6 GHz band, and the probe response received within the 6 GHz band, the

probe response including a basic service set identification (BSSID) of the HE AP, where the HE AP is a member of an extended service set (ESS) with the SSID.

[00201] In Example 2, the subject matter of Example 1 optionally includes
5 where the processing circuitry is configured to: refrain from setting the SSID field to indicate a wildcard SSID.

[00202] In Example 3, the subject matter of any one or more of Examples 1–2 optionally include where the processing circuitry is further configured to: encode a reassociation request, the reassociation request including a destination
10 address indicating the BSSID of the HE AP; and generate signaling to transmit the reassociation request on the subchannel.

[00203] In Example 4, the subject matter of any one or more of Examples 1–3 optionally include where the processing circuitry is further configured to: encode an association request, the association request including a destination
15 address indicating the BSSID of the HE AP; generate signaling to cause the HE STA to transmit the association request within the 6 GHz band; and decode an association frame, the association frame including an association identification for the HE STA to communication with the HE AP.

[00204] In Example 5, the subject matter of any one or more of Examples 1–4 optionally include where the frame is one from the following group: a
20 neighbor report, a beacon frame, and a probe response.

[00205] In Example 6, the subject matter of Example 5 optionally includes 6 GHz band. In Example 7, the subject matter of any one or more of Examples 1–6 optionally include where the processing circuitry is configured to: decode a
25 neighbor report, the neighbor report including a BSSID field, the BSSID field indicating another BSSID of an AP, the neighbor report further including a BSSID information field, the BSSID information including one or more fields to indicate whether the AP is a high-throughput (HT) AP, a very-high throughput (VHT) AP, a HE AP, or another 6 GHz HE AP.

30 [00206] In Example 8, the subject matter of Example 7 optionally includes where the processing circuitry is further configured to: in response to the AP

being the another HE AP, encode an association request or a re-association request, the association request or the re-association request including a BSSID field, the BSSID field indicating the another BSSID.

[00207] In Example 9, the subject matter of any one or more of Examples 1–8 optionally include where the processing circuitry is configured to: decode a reduced neighbor report, the reduced neighbor report including a target beacon transmit time (TBTT) information field, the TBTT information field including a first format and a second format, where the reduced neighbor report indicates whether the TBTT information field is the first format or the second format, where the first format comprises a neighbor AP TBTT offset field, the neighbor AP TBTT offset field indicating an offset in time units (TUs) rounded down to a nearest TU until a next TBTT of a first AP from an immediately prior TBTT of a second AP from which the reduced neighbor report was received, and where the second format comprises the neighbor AP TBTT offset field and a beacon interval field, the beacon interval field indicating a beacon interval of the AP.

[00208] In Example 10, the subject matter of Example 9 optionally includes where the processing is further configured to: wait for the next TBTT of the first AP; decode a beacon frame from the first AP, the beacon frame received on another channel indicated by the reduced neighbor report; determine whether the first AP is another HE AP based on the beacon frame; and in response to the first AP being another HE AP, determine another BSSID of the first AP based on the beacon frame, encode an association frame or a re-association frame, the association frame or the re-association frame to include the BSSID of the first AP, and configure the HE STA to transmit the association frame or the re-association frame on the another channel within the 6 GHz band.

[00209] In Example 11, the subject matter of any one or more of Examples 9–10 optionally include where the reduced neighbor report comprises a field to indicate whether the first AP is co-located with the second AP.

[00210] In Example 12, the subject matter of any one or more of Examples 1–11 optionally include where the SSID is an SSID of an extended service set to which the HE STA is associated with.

[00211] In Example 13, the subject matter of any one or more of Examples 1–12 optionally include access point. In Example 14, the subject matter of any one or more of Examples 1–13 optionally include transceiver circuitry coupled to the processing circuitry.

- 5 [00212] In Example 15, the subject matter of Example 14 optionally includes one or more antennas coupled to the transceiver circuitry. Example 16 is a non-transitory computer-readable storage medium that stores instructions for execution by one or more processors of an apparatus of a high-efficiency (HE) station (STA), the HE STA configured to operate in a 6 GHz band, the
- 10 instructions to configure the one or more processors to: decode a frame including a service set identification (SSID) and an indication of whether 6 GHz HE operation is supported, where the frame is received on a 2.4 GHz band or a 5 GHz band; in response to the indication indicating that 6 GHz HE operation is supported, encode a probe request frame to include a SSID field set to the SSID
- 15 and encode the probe request frame to include a destination address field set to a broadcast destination address, generate signaling to transmit the probe request frame on a subchannel within a 6 GHz band, and decode a probe response from a HE access point (AP), the HE AP configured to operate in the 6 GHz band, and the probe response received within the 6 GHz band, the probe response including
- 20 a basic service set identification (BSSID) of the HE AP, where the HE AP is a member of an extended service set (ESS) with the SSID.

[00213] In Example 17, the subject matter of Example 16 optionally includes where the instructions further configure the one or more processors to: refrain from setting the SSID field to indicate a wildcard SSID.

- 25 [00214] Example 18 is a method performed by an apparatus of a high-efficiency (HE) station (STA), the HE STA configured to operate in a 6 GHz band, the method including: decoding a frame including a service set identification (SSID) and an indication of whether 6 GHz HE operation is supported, where the frame is received on a 2.4 GHz band or a 5 GHz band; in
- 30 response to the indication indicating that 6 GHz HE operation is supported, encoding a probe request frame to include a SSID field set to the SSID and

encode the probe request frame to include a destination address field set to a broadcast destination address, generating signaling to transmit the probe request frame on a subchannel within a 6 GHz band, and decoding a probe response from a HE access point (AP), the HE AP configured to operate in the 6 GHz band, and the probe response received within the 6 GHz band, the probe response including a basic service set identification (BSSID) of the HE AP, where the HE AP is a member of an extended service set (ESS) with the SSID.

[00215] Example 19 is a method of Example 18, where the method further comprises: refraining from setting the SSID field to indicate a wildcard SSID.

10 Example 20 is an apparatus of a high-efficiency (HE) access point (AP), the HE AP configured to operate in a 6 GHz band, the apparatus including: memory; and processing circuitry coupled to the memory, the processing circuitry configured to: decode a probe request frame, the probe request including a service set identification (SSID) field and a destination address field with a value of a broadcast destination address; in response to a value of the SSID field being a SSID of an extended service set (ESS) of the 6 GHz HE AP, encoding a probe response, the probe response including a basic service set identification (BSSID) of the 6 GHz HE access point (AP), and generate signaling to transmit the probe response frame on a subchannel within a 6 GHz band.

20 [00216] In Example 21, the subject matter of Example 20 optionally includes GHz band. In Example 22, the subject matter of any one or more of Examples 20–21 optionally include where the processing circuitry is configured to: encode a neighbor report, the neighbor report to include a BSSID field, the BSSID field indicating the BSSID of the HE AP, the neighbor report further including a BSSID information field, the BSSID information including one or more fields to indicate that the HE AP is configured to operate in the 6 GHz band.

[00217] In Example 23, the subject matter of Example 22 optionally includes where the processing circuitry is further configured to: generate signaling to transmit the neighbor report on another subchannel within a 2.4 GHz band or a 5 GHz band.

[00218] In Example 24, the subject matter of any one or more of Examples 20–23 optionally include access point. In Example 25, the subject matter of any one or more of Examples 20–24 optionally include transceiver circuitry coupled to the processing circuitry; and one or more antennas coupled to the transceiver circuitry.

[00219] Example 26 is a non-transitory computer-readable storage medium that stores instructions for execution by one or more processors of an apparatus of a high-efficiency (HE) access point (AP), the HE AP configured to operate in a 6 GHz band, the instructions to configure the one or more processors to: decode a probe request frame, the probe request including a service set identification (SSID) field and a destination address field with a value of a broadcast destination address; in response to a value of the SSID field being a SSID of an extended service set (ESS) of the 6 GHz HE AP, encoding a probe response, the probe response including a basic service set identification (BSSID) of the 6 GHz HE access point (AP), and generate signaling to transmit the probe response frame on a subchannel within a 6 GHz band.

[00220] In Example 27, the subject matter of Example 26 optionally includes GHz band. In Example 28, the subject matter of any one or more of Examples 26–27 optionally include where the instructions further configure the one or more processors to: encode a neighbor report, the neighbor report to include a BSSID field, the BSSID field indicating the BSSID of the HE AP, the neighbor report further including a BSSID information field, the BSSID information including one or more fields to indicate that the HE AP is configured to operate in the 6 GHz band.

[00221] In Example 29, the subject matter of Example 28 optionally includes where the instructions further configure the one or more processors to: generate signaling to transmit the neighbor report on another subchannel within a 2.4 GHz band or a 5 GHz band.

[00222] Example 30 is a method, the method performed on an apparatus of a high-efficiency (HE) access point (AP), the HE AP configured to operate in a 6 GHz band, the method including: decode a probe request frame, the probe

request including a service set identification (SSID) field and a destination address field with a value of a broadcast destination address; in response to a value of the SSID field being a SSID of an extended service set (ESS) of the 6 GHz HE AP, encoding a probe response, the probe response including a basic service set identification (BSSID) of the 6 GHz HE access point (AP), and generate signaling to transmit the probe response frame on a subchannel within a 6 GHz band.

[00223] In Example 31, the subject matter of Example 30 optionally includes GHz band. In Example 32, the subject matter of any one or more of Examples 30–31 optionally include the method further including: encoding a neighbor report, the neighbor report to include a BSSID field, the BSSID field indicating the BSSID of the HE AP, the neighbor report further including a BSSID information field, the BSSID information including one or more fields to indicate that the HE AP is configured to operate in the 6 GHz band.

[00224] In Example 33, the subject matter of Example 32 optionally includes the method further including: generating signaling to transmit the neighbor report on another subchannel within a 2.4 GHz band or a 5 GHz band.

[00225] Example 34 is an apparatus of a high-efficiency (HE) access point (AP), the HE AP configured to operate in a 6 GHz band, the apparatus including: means for decode a probe request frame, the probe request including a service set identification (SSID) field and a destination address field with a value of a broadcast destination address; in response to a value of the SSID field being a SSID of an extended service set (ESS) of the 6 GHz HE AP, means for encoding a probe response, the probe response including a basic service set identification (BSSID) of the 6 GHz HE access point (AP), and generate signaling to transmit the probe response frame on a subchannel within a 6 GHz band.

[00226] In Example 35, the subject matter of Example 34 optionally includes GHz band.

[00227] In Example 36, the subject matter of any one or more of Examples 34–35 optionally include the apparatus further including: means for encoding a neighbor report, the neighbor report to include a BSSID field, the

BSSID field indicating the BSSID of the HE AP, the neighbor report further including a BSSID information field, the BSSID information including one or more fields to indicate that the HE AP is configured to operate in the 6 GHz band.

- 5 [00228] In Example 37, the subject matter of Example 36 optionally includes the apparatus further including: means for generating signaling to transmit the neighbor report on another subchannel within a 2.4 GHz band or a 5 GHz band.

- 10 [00229] Example 38 is an apparatus of a high-efficiency (HE) station (STA), the apparatus including: means for operating in a 6 GHz band; means for decoding a frame including a service set identification (SSID) and an indication of whether 6 GHz HE operation is supported, where the frame is received on a 2.4 GHz band or a 5 GHz band; in response to the indication indicating that 6 GHz HE operation is supported, means for encoding a probe request frame to
15 include a SSID field set to the SSID and encode the probe request frame to include a destination address field set to a broadcast destination address, means for generating signaling to transmit the probe request frame on a subchannel within a 6 GHz band, and means for decoding a probe response from a HE access point (AP), the HE AP configured to operate in the 6 GHz band, and the
20 probe response received within the 6 GHz band, the probe response including a basic service set identification (BSSID) of the HE AP, where the HE AP is a member of an extended service set (ESS) with the SSID.

- 25 [00230] In Example 39, the subject matter of Example 38 optionally includes where the apparatus further comprises: means for refraining from setting the SSID field to indicate a wildcard SSID.

- 30 [00231] The Abstract is provided to comply with 37 C.F.R. Section 1.72(b) requiring an abstract that will allow the reader to ascertain the nature and gist of the technical disclosure. It is submitted with the understanding that it will not be used to limit or interpret the scope or meaning of the claims. The following claims are hereby incorporated into the detailed description, with each claim standing on its own as a separate embodiment.

CLAIMS

What is claimed is:

1. An apparatus of a high-efficiency (HE) station (STA), the HE
5 STA configured to operate in a 6 GHz band, the apparatus comprising: memory;
and processing circuitry coupled to the memory, the processing circuitry
configured to:

decode a frame comprising a service set identification (SSID) and an
indication of whether 6 GHz HE operation is supported, wherein the frame is
10 received on a 2.4 GHz band or a 5 GHz band;

in response to the indication indicating that 6 GHz HE operation is
supported, encode a probe request frame to include a SSID field set to the SSID
and encode the probe request frame to include a destination address field set to a
broadcast destination address,

15 generate signaling to transmit the probe request frame on a subchannel
within the 6 GHz band, and

decode a probe response from a HE access point (AP), the HE AP
configured to operate in the 6 GHz band, and the probe response received within
the 6 GHz band, the probe response comprising a basic service set identification
20 (BSSID) of the HE AP, wherein the HE AP is a member of an extended service
set (ESS) with the SSID.

2. The apparatus of claim 1, wherein the processing circuitry is
configured to:

25 refrain from setting the SSID field to indicate a wildcard SSID.

3. The apparatus of claim 1, wherein the processing circuitry is
further configured to:

encode a reassociation request, the reassociation request including a
30 destination address indicating the BSSID of the HE AP; and

generate signaling to transmit the reassociation request on the subchannel.

4. The apparatus of claim 1, wherein the processing circuitry is
5 further configured to:

encode an association request, the association request including a destination address indicating the BSSID of the HE AP;

generate signaling to cause the HE STA to transmit the association request within the 6 GHz band; and

10 decode an association frame, the association frame comprising an association identification for the HE STA to communication with the HE AP.

5. The apparatus of claim 1, wherein the frame is one from the following group: a neighbor report, a beacon frame, and a probe response.

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6. The apparatus of claim 5, wherein the neighbor report is received from another HE AP on a channel within the 2.4 GHz band or the 5 GHz band.

7. The apparatus of claim 1, wherein the processing circuitry is
20 configured to:

decode a neighbor report, the neighbor report comprising a BSSID field, the BSSID field indicating another BSSID of an AP, the neighbor report further comprising a BSSID information field, the BSSID information comprising one or more fields to indicate whether the AP is a high-throughput (HT) AP, a very-high throughput (VHT) AP, a HE AP, or another 6 GHz HE AP.
25

8. The apparatus of claim 7, wherein the processing circuitry is further configured to:

in response to the AP being the another HE AP, encode an association request or a re-association request, the association request or the re-association
30

request comprising a BSSID field, the BSSID field indicating the another BSSID.

9. The apparatus of claim 1, wherein the processing circuitry is
5 configured to:

decode a reduced neighbor report, the reduced neighbor report comprising a target beacon transmit time (TBTT) information field, the TBTT information field including a first format and a second format, wherein the reduced neighbor report indicates whether the TBTT information field is the first
10 format or the second format, wherein the first format comprises a neighbor AP TBTT offset field, the neighbor AP TBTT offset field indicating an offset in time units (TUs) rounded down to a nearest TU until a next TBTT of a first AP from an immediately prior TBTT of a second AP from which the reduced neighbor report was received, and wherein the second format comprises the
15 neighbor AP TBTT offset field and a beacon interval field, the beacon interval field indicating a beacon interval of the AP.

10. The apparatus of claim 9, wherein the processing is further configured to:
20 wait for the next TBTT of the first AP;
decode a beacon frame from the first AP, the beacon frame received on another channel indicated by the reduced neighbor report;
determine whether the first AP is another HE AP based on the beacon frame; and

25 in response to the first AP being another HE AP, determine another BSSID of the first AP based on the beacon frame, encode an association frame or a re-association frame, the association frame or the re-association frame to include the BSSID of the first AP, and configure the HE STA to transmit the association frame or the re-association frame on the another channel within the 6
30 GHz band.

11. The apparatus of claim 9, wherein the reduced neighbor report comprises a field to indicate whether the first AP is co-located with the second AP.

5 12. The apparatus of claim 1, wherein the HE STA is associated with the ESS having the SSID.

13. The apparatus of claim 1, wherein the HE STA and the HE AP are each one from the following group: an Institute of Electrical and Electronic
10 Engineers (IEEE) 802.11ax access point configured to operate in the 6 GHz band, an IEEE 802.11ax station configured to operate in the 6 GHz band, an IEEE 802.11 station, and an IEEE 802.11 access point.

14. The apparatus of claim 1, further comprising transceiver circuitry
15 coupled to the processing circuitry.

15. The apparatus of claim 14, further comprising one or more antennas coupled to the transceiver circuitry.

20 16. A non-transitory computer-readable storage medium that stores instructions for execution by one or more processors of an apparatus of a high-efficiency (HE) station (STA), the HE STA configured to operate in a 6 GHz band, the instructions to configure the one or more processors to:

25 decode a frame comprising a service set identification (SSID) and an indication of whether 6 GHz HE operation is supported, wherein the frame is received on a 2.4 GHz band or a 5 GHz band;

in response to the indication indicating that 6 GHz HE operation is supported, encode a probe request frame to include a SSID field set to the SSID and encode the probe request frame to include a destination address field set to a
30 broadcast destination address,

generate signaling to transmit the probe request frame on a subchannel within a 6 GHz band, and

5 decode a probe response from a HE access point (AP), the HE AP configured to operate in the 6 GHz band, and the probe response received within the 6 GHz band, the probe response comprising a basic service set identification (BSSID) of the HE AP, wherein the HE AP is a member of an extended service set (ESS) with the SSID.

10 17. The non-transitory computer-readable storage medium of claim 16, wherein the instructions further configure the one or more processors to: refrain from setting the SSID field to indicate a wildcard SSID.

15 18. A method performed by an apparatus of a high-efficiency (HE) station (STA), the HE STA configured to operate in a 6 GHz band, the method comprising:

decoding a frame comprising a service set identification (SSID) and an indication of whether 6 GHz HE operation is supported, wherein the frame is received on a 2.4 GHz band or a 5 GHz band;

20 in response to the indication indicating that 6 GHz HE operation is supported, encoding a probe request frame to include a SSID field set to the SSID and encode the probe request frame to include a destination address field set to a broadcast destination address,

generating signaling to transmit the probe request frame on a subchannel within a 6 GHz band, and

25 decoding a probe response from a HE access point (AP), the HE AP configured to operate in the 6 GHz band, and the probe response received within the 6 GHz band, the probe response comprising a basic service set identification (BSSID) of the HE AP, wherein the HE AP is a member of an extended service set (ESS) with the SSID.

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19. A method of claim 18, wherein the method further comprises:

refraining from setting the SSID field to indicate a wildcard SSID.

20. An apparatus of a high-efficiency (HE) access point (AP), the HE AP configured to operate in a 6 GHz band, the apparatus comprising: memory;
5 and processing circuitry coupled to the memory, the processing circuitry configured to:

decode a probe request frame, the probe request comprising a service set identification (SSID) field and a destination address field with a value of a broadcast destination address;

10 in response to a value of the SSID field being a SSID of an extended service set (ESS) of the 6 GHz HE AP, encoding a probe response, the probe response comprising a basic service set identification (BSSID) of the 6 GHz HE access point (AP), and generate signaling to transmit the probe response frame on a subchannel within a 6 GHz band.

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21. The apparatus of claim 20, wherein the probe request frame is received on the subchannel within the 6 GHz band.

22. The apparatus of claim 20, wherein the processing circuitry is
20 configured to:

encode a neighbor report, the neighbor report to include a BSSID field, the BSSID field indicating the BSSID of the HE AP, the neighbor report further comprising a BSSID information field, the BSSID information comprising one or more fields to indicate that the HE AP is configured to operate in the 6 GHz
25 band.

23. The apparatus of claim 22, wherein the processing circuitry is further configured to:

generate signaling to transmit the neighbor report on another subchannel
30 within a 2.4 GHz band or a 5 GHz band.

24. The apparatus of claim 20, wherein the 6 GHz HE AP is one from the following group: an Institute of Electrical and Electronic Engineers (IEEE) 802.11ax access point, an IEEE 802.11ax station, an IEEE 802.11 station, and an IEEE 802.11 access point.

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25. The apparatus of claim 20, further comprising transceiver circuitry coupled to the processing circuitry; and one or more antennas coupled to the transceiver circuitry.

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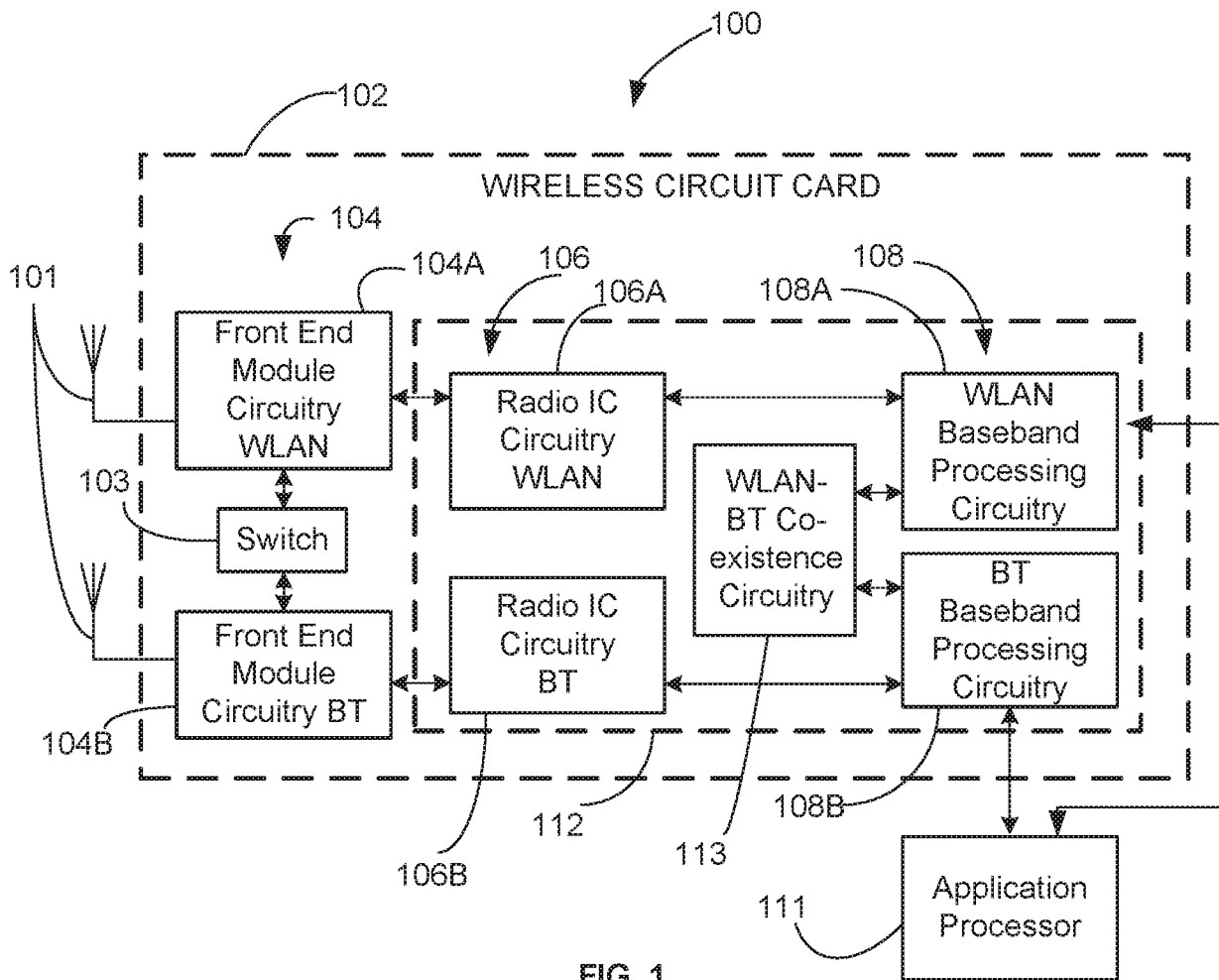


FIG. 1

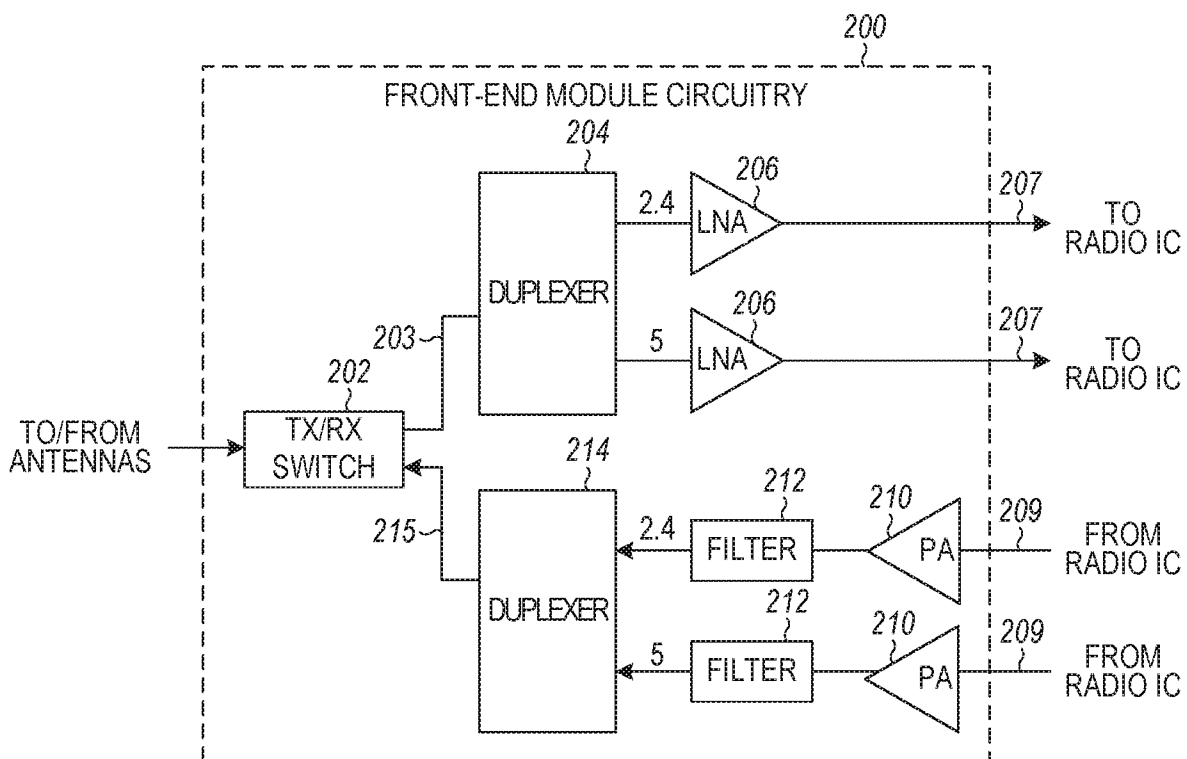


FIG. 2

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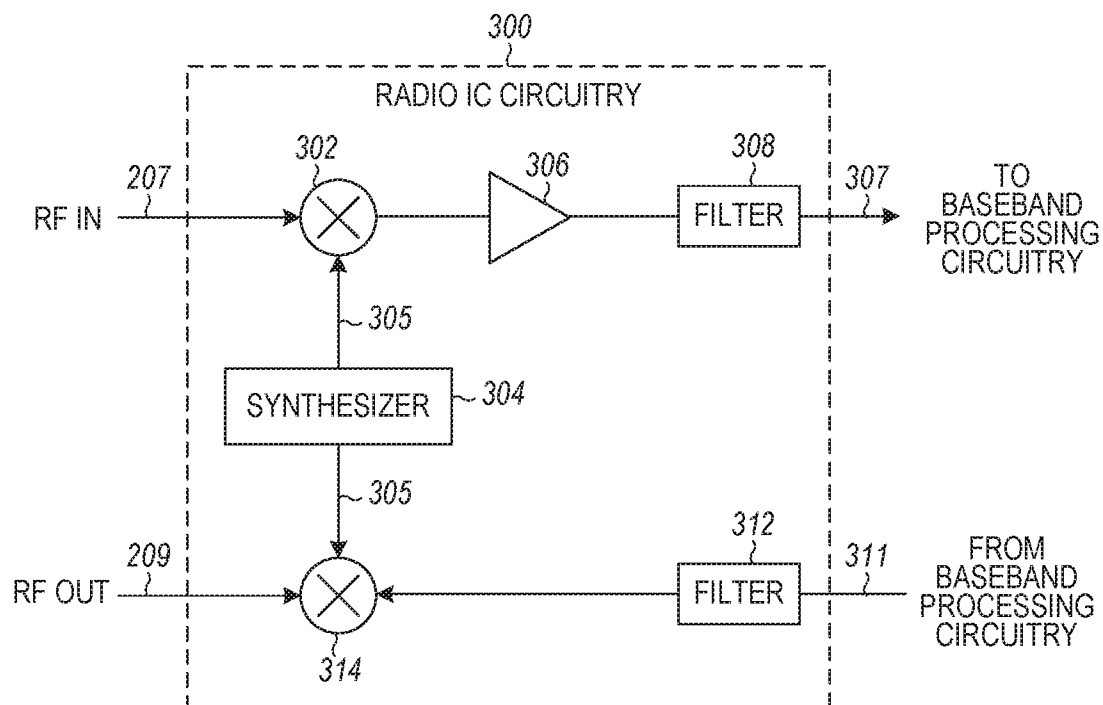


FIG. 3

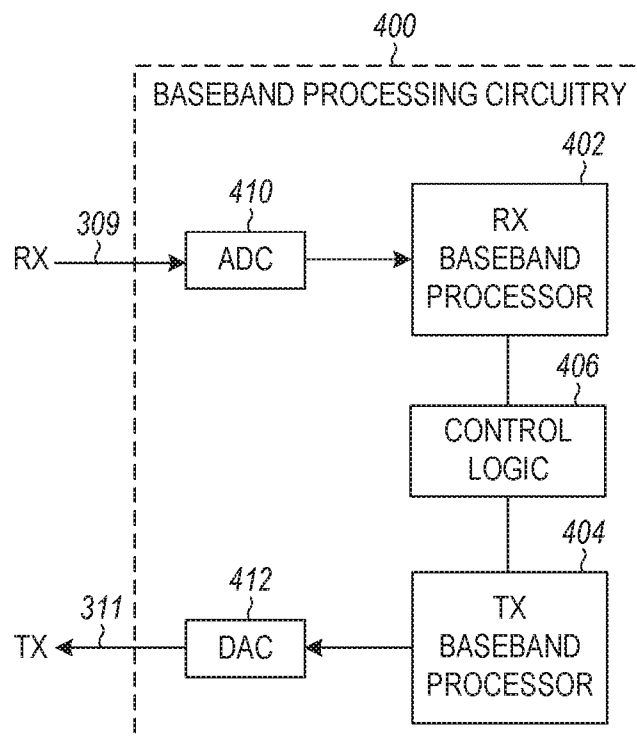


FIG. 4

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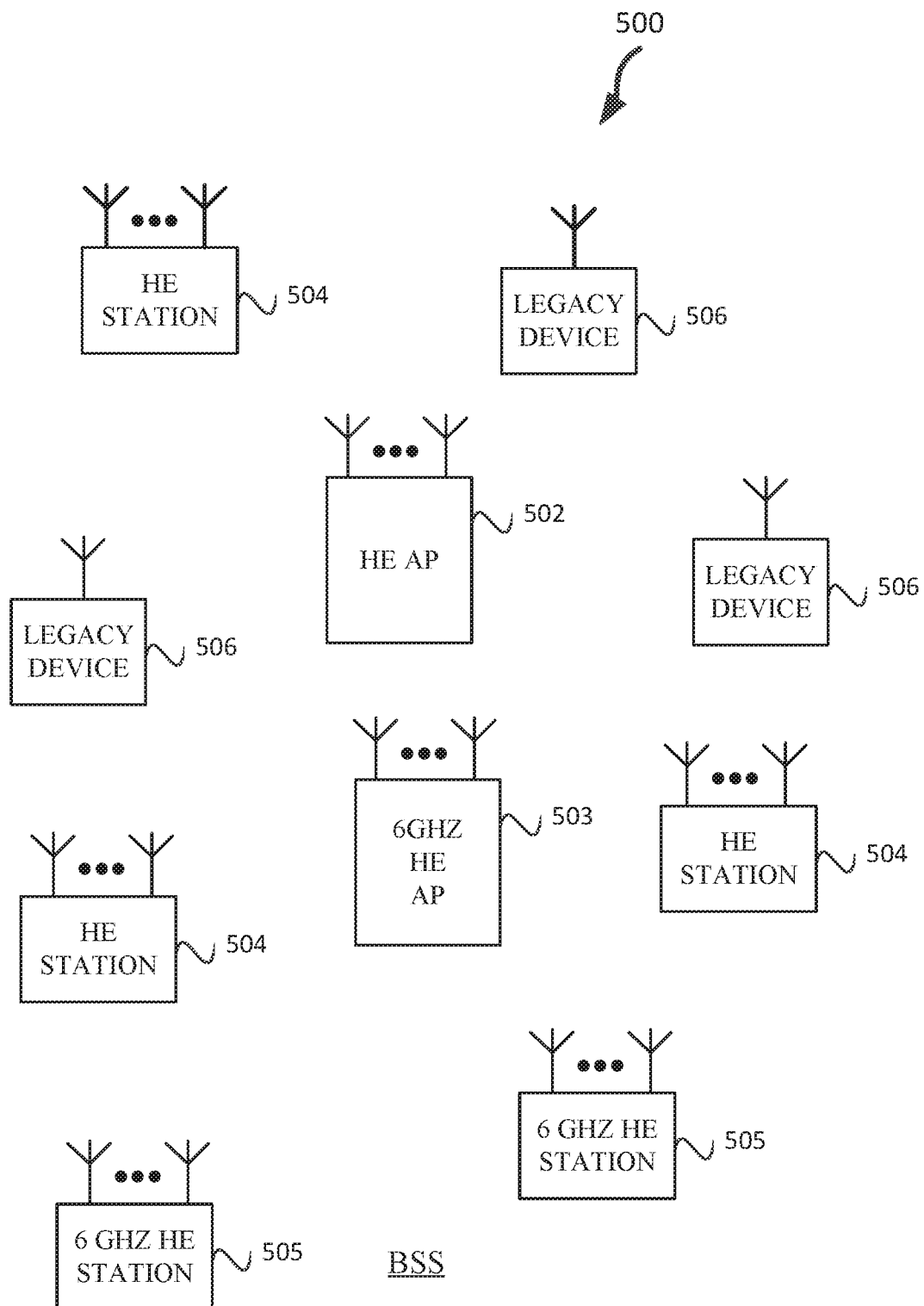
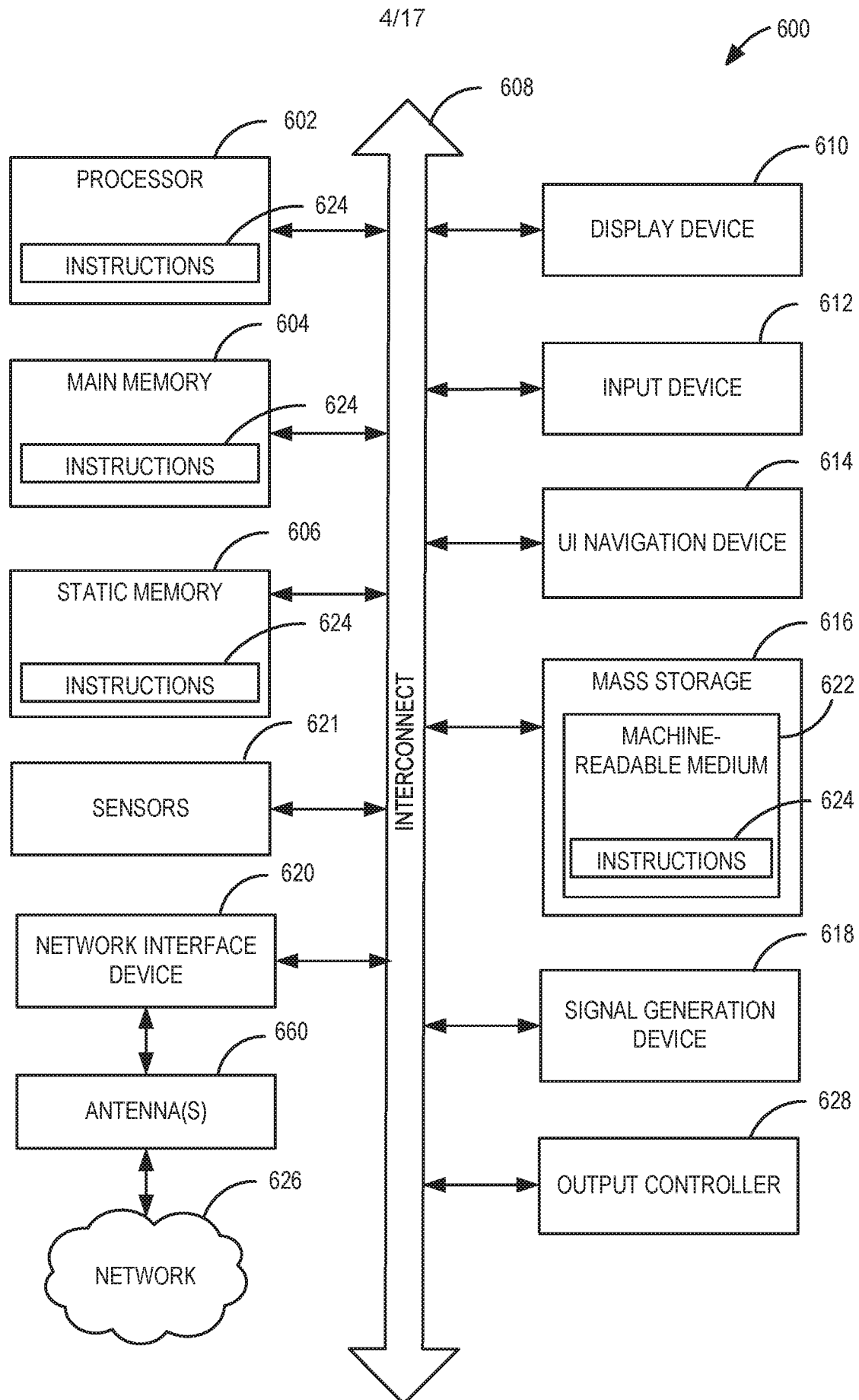
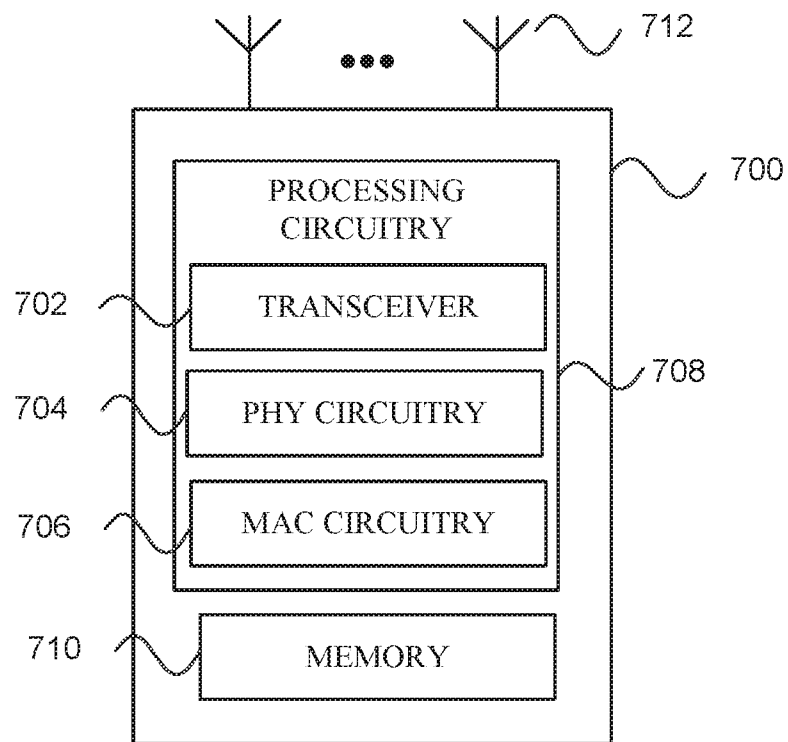
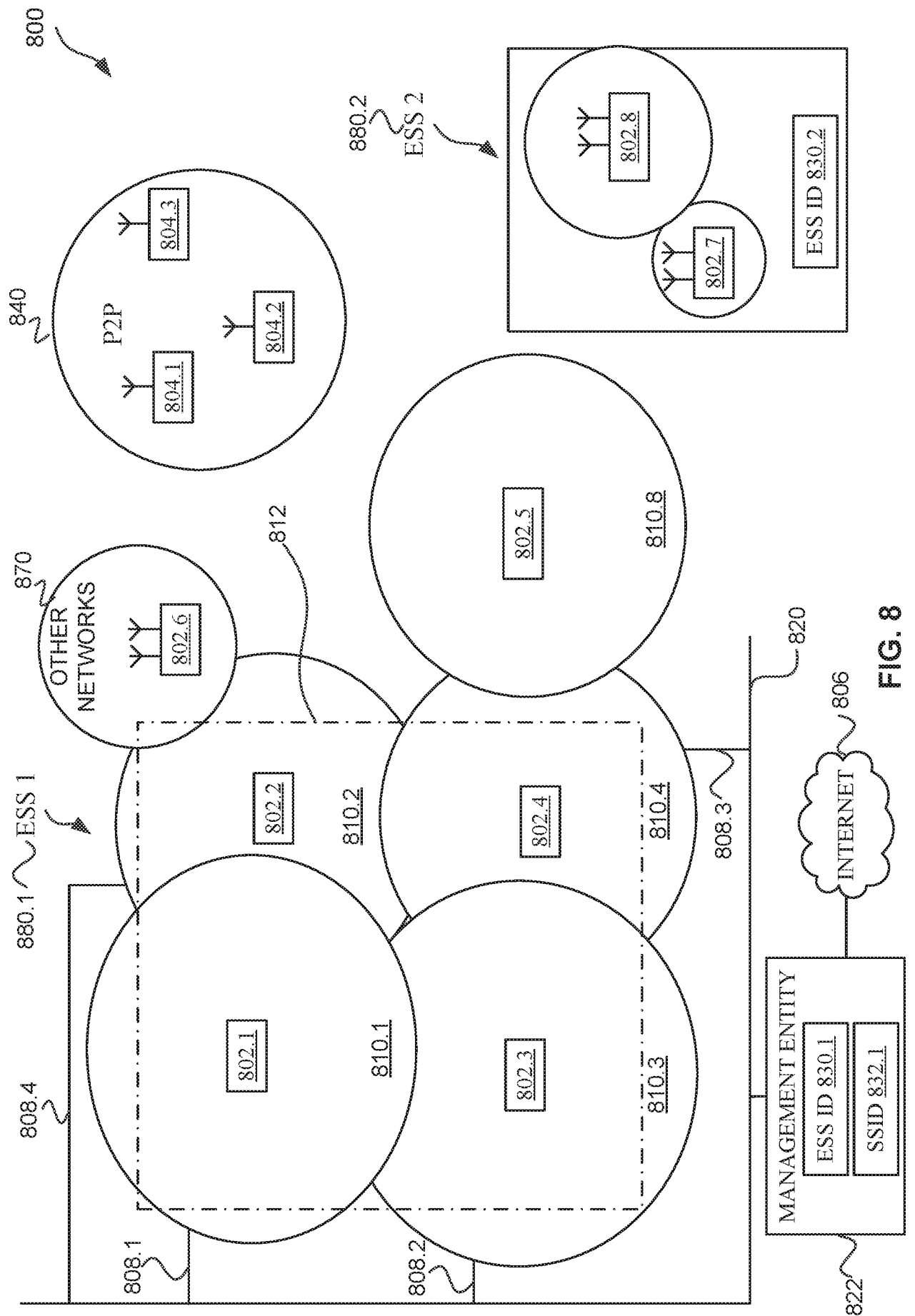


FIG. 5



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**FIG. 7**



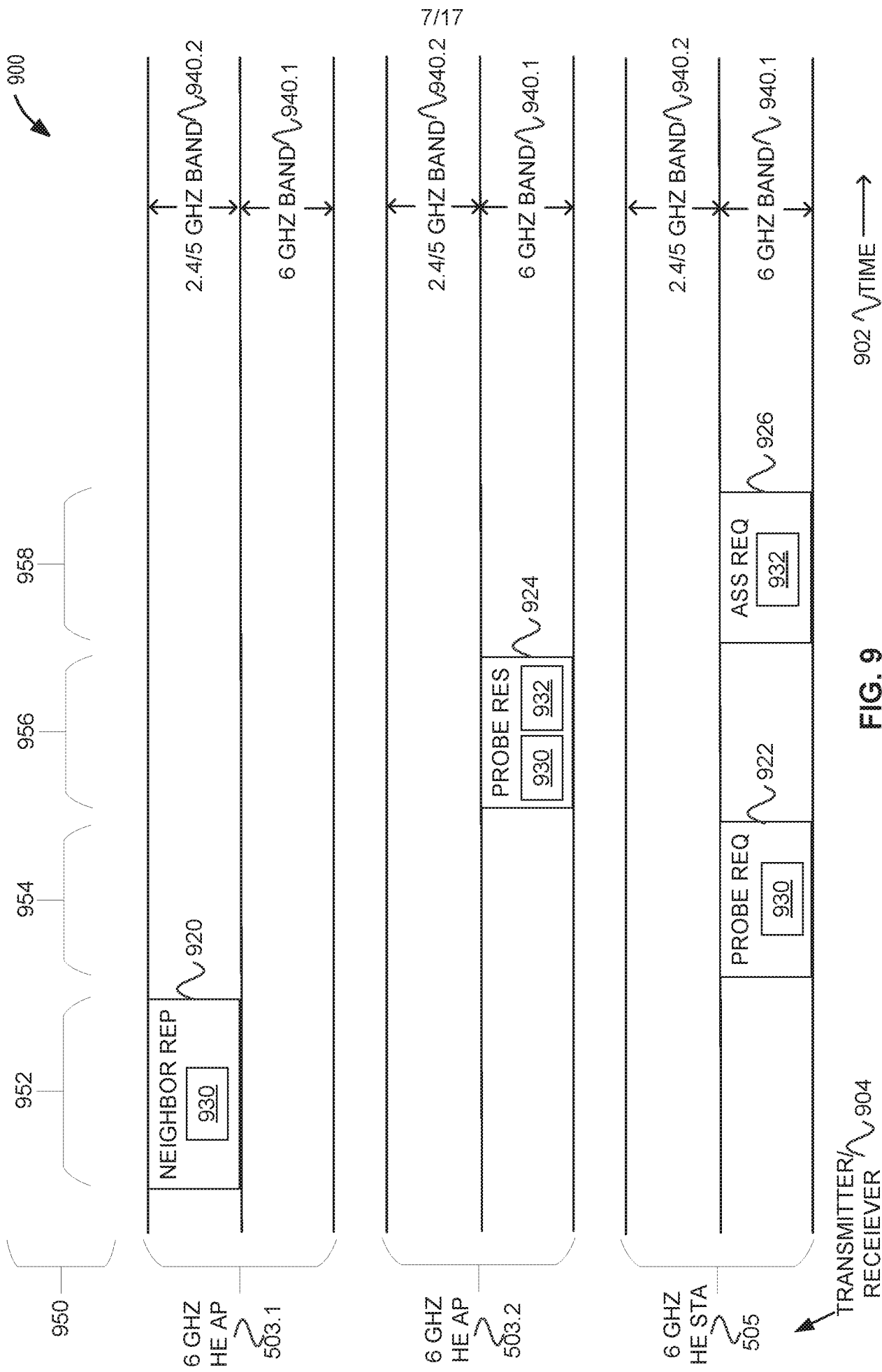


FIG. 9

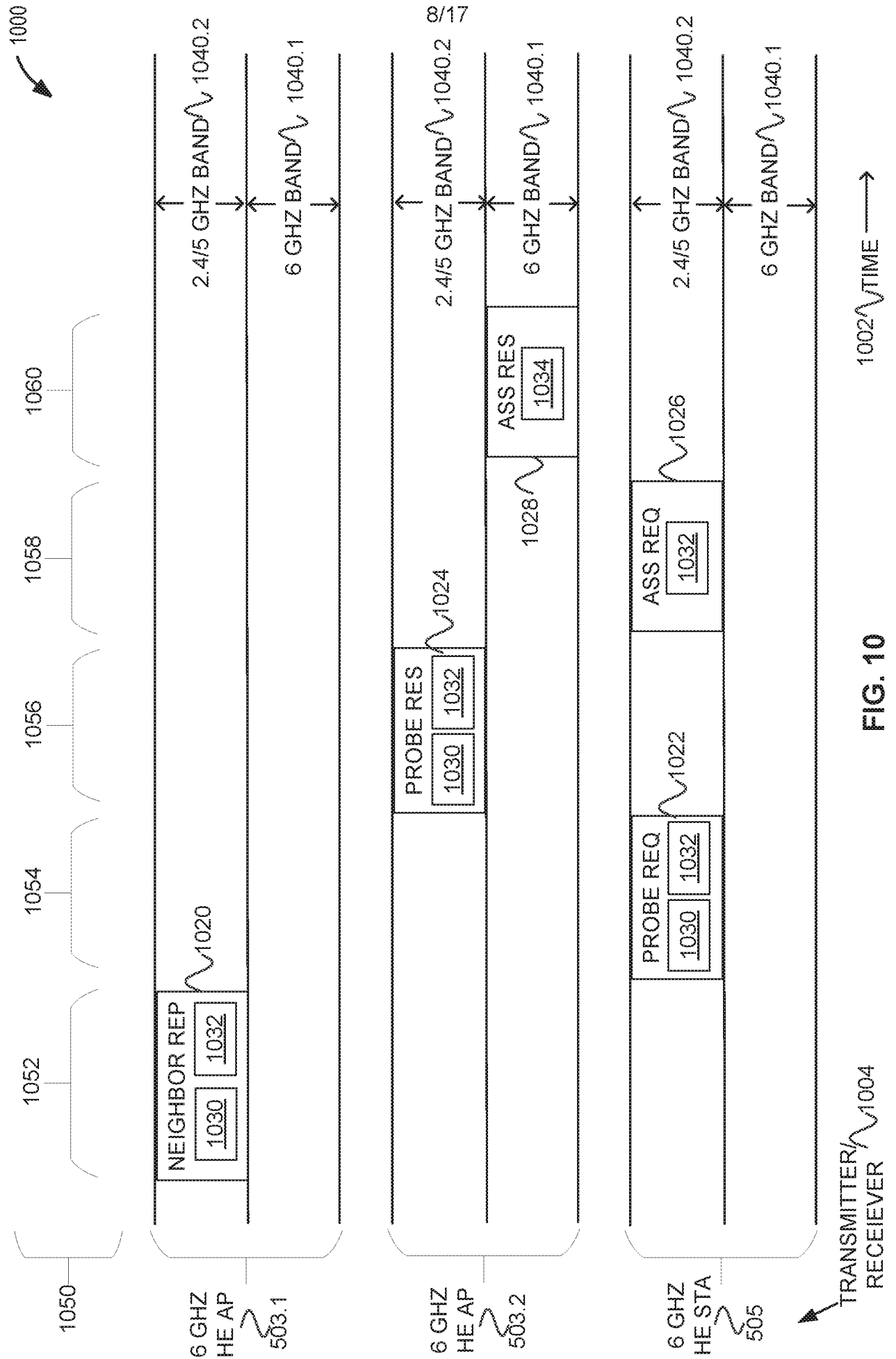


FIG. 10

1100

ELEMENT ID 1102	LENGTH 1104	BSSID 1106	BSSID INFORMATION 1108	OPERATING CLASS 1110	CHANNEL NUMBER 1112	PHY TYPE 1114	OPTIONAL SUB-ELEMENTS 1116
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OCTETS
1118

FIG. 11

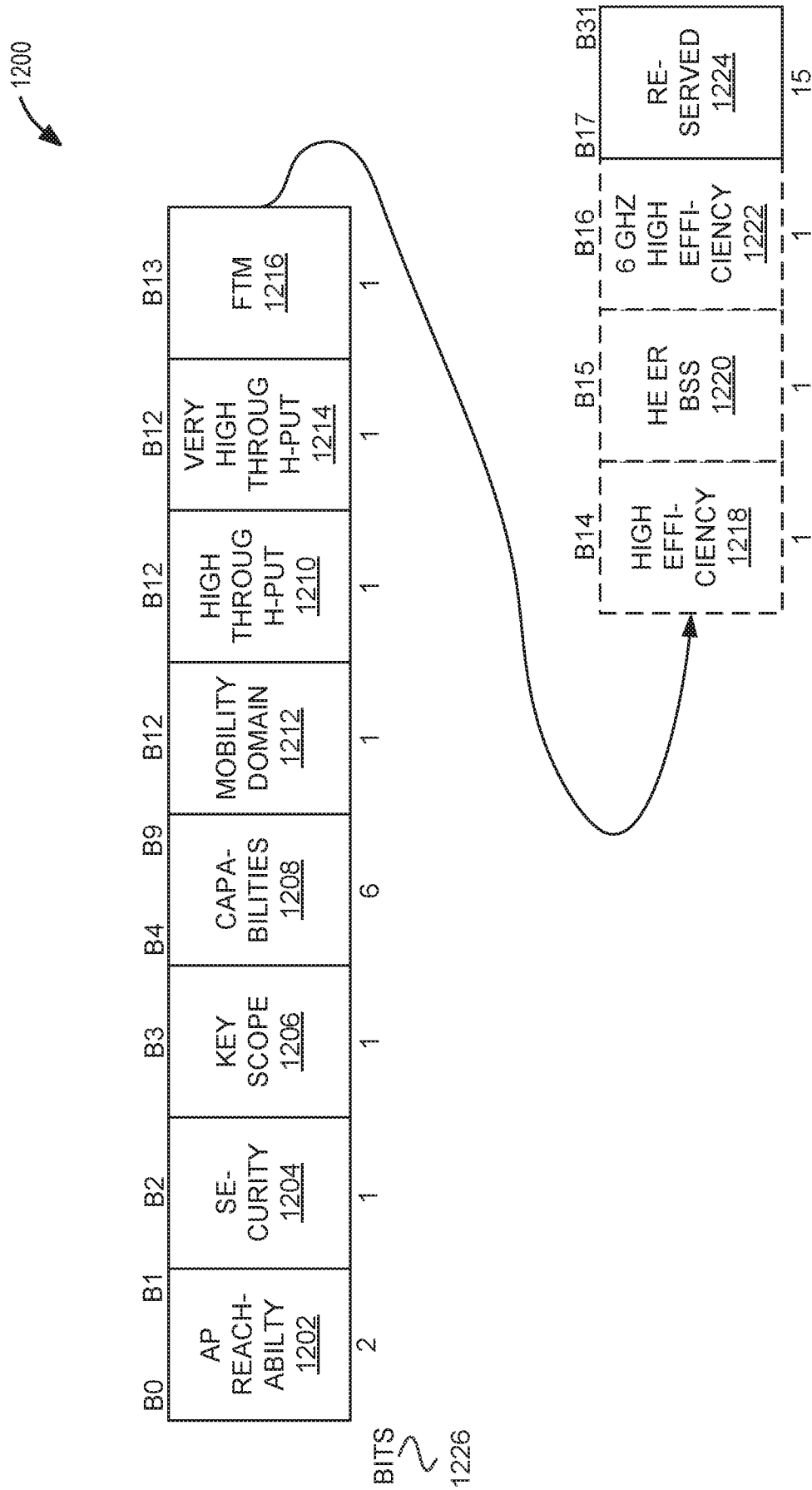
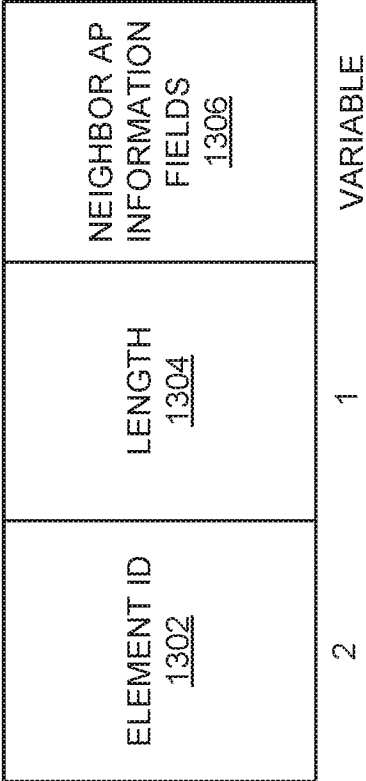


FIG. 12

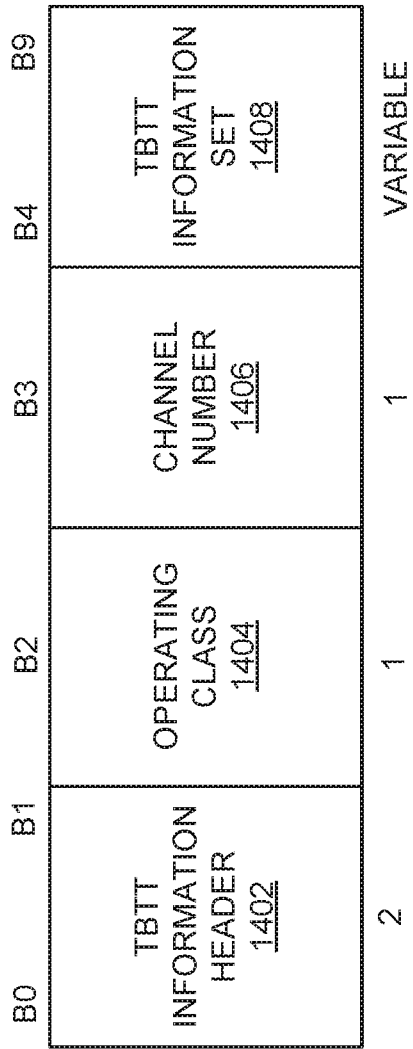
1300



OCTETS
1310

FIG. 13

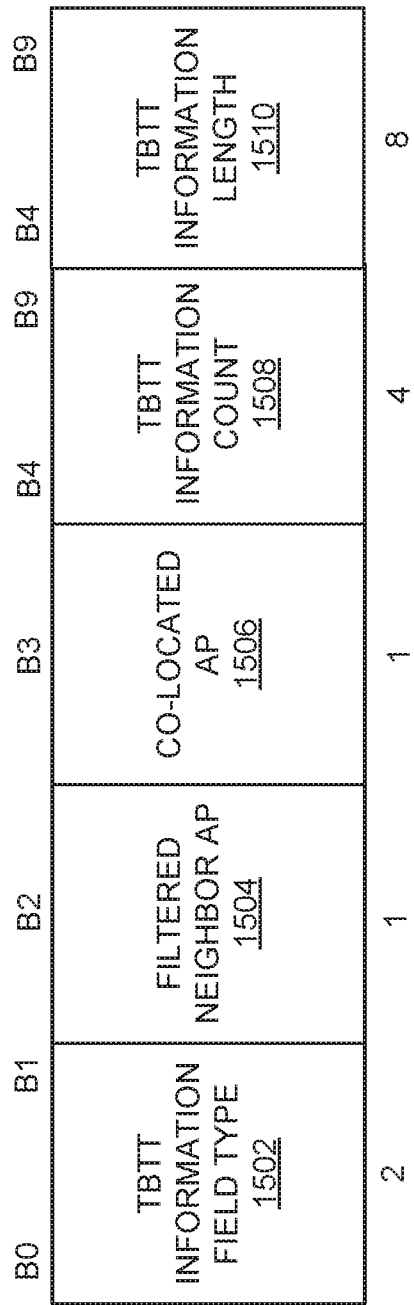
1400



OCTETS
1410

FIG. 14

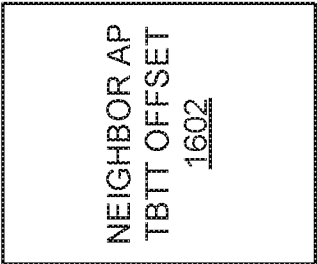
1500



BITS
1512

FIG. 15

1600

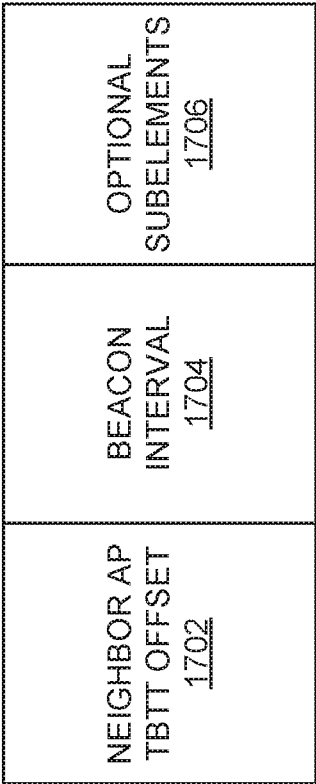


OCTETS
1604

1

FIG. 16

1700



OCTETS
1708

1

2

VARIABLE

FIG. 17

1800

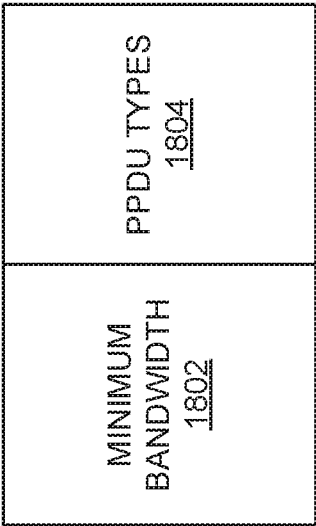


FIG. 18

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1900

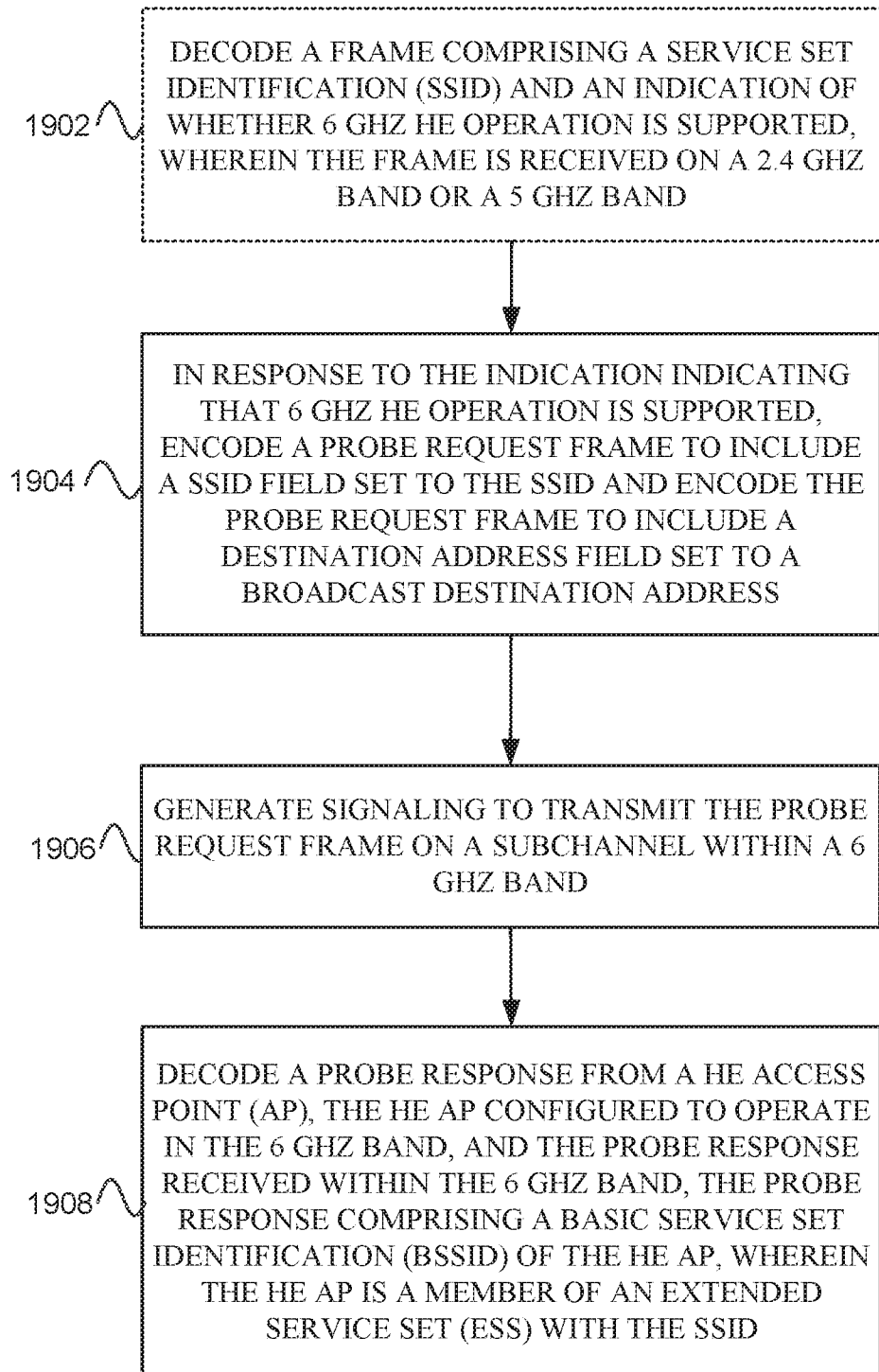


FIG. 19

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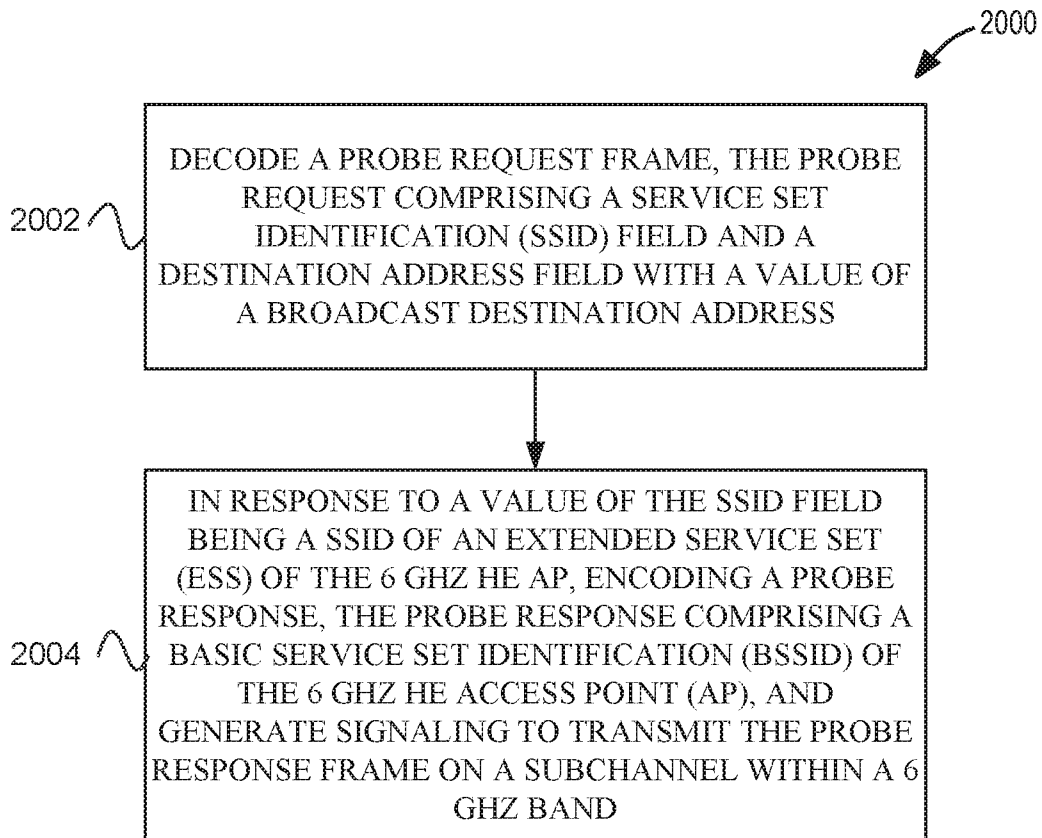


FIG. 20

A. CLASSIFICATION OF SUBJECT MATTER**H04W 48/14(2009.01)i, H04W 48/16(2009.01)i, H04W 84/12(2009.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W 48/14; H04B 7/04; H04B 7/06; H04L 1/00; H04L 27/26; H04W 48/08; H04W 48/10; H04W 48/16; H04W 84/12

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: high-efficiency (HE) station (STA), HE AP, 6GHz, service set identification (SSID), probe request, probe response, basic service set identification (BSSID), extended service set (ESS), neighbor report

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015-0257085 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 10 September 2015 See paragraphs [0077]-[0108]; and figure 3.	1-25
A	US 2016-0315681 A1 (NEWRACOM, INC.) 27 October 2016 See paragraph [0195]; and figure 23.	1-25
A	WO 2016-017947 A1 (LG ELECTRONICS INC.) 04 February 2016 See paragraphs [222]-[236]; and figure 10.	1-25
A	KR 10-2015-0044882 A (LG ELECTRONICS INC.) 27 April 2015 See paragraphs [0136]-[0147]; and figure 11.	1-25
A	ELDAD PERAHIA et al., 'High efficiency WLAN overview', IEEE 802.11-14/0214r2, 18 February 2014 See slides 2-10.	1-25



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

28 September 2018 (28.09.2018)

Date of mailing of the international search report

28 September 2018 (28.09.2018)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2018/037575

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