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1	Application Data Sheet	153742P1_ADS.PDF	1561309 2f7a3b148866a008d79579cf6ee38b4bc87 11c0c	no	7
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TECHNIQUES FOR SIGNAL EXTENSION SIGNALING

BACKGROUND

[0001] The present disclosure relates generally to telecommunications, and specifically to techniques for signal extension signaling.

[0002] The deployment of wireless local area networks (WLANs) in the home, the office, and various public facilities is commonplace today. Such networks typically employ a wireless access point (AP) that connects a number of wireless stations (STAs) in a specific locality (e.g., home, office, public facility, etc.) to another network, such as the Internet or the like. A set of STAs can communicate with each other through a common AP in what is referred to as a basic service set (BSS). Nearby BSSs may have overlapping coverage areas and such BSSs may be referred to as overlapping BSSs or OBSSs.

[0003] In order to address the desire for greater data throughput using WLANs (e.g., Wi-Fi networks), different approaches are being considered. For example, in the IEEE 802.11ax Wi-Fi standard, a larger number of tones are processed and decoded when compared to earlier or legacy Wi-Fi standards (e.g., IEEE 802.11ac). The larger number of tones allows more data to be transmitted in the same bandwidth and time period.

[0004] The processing of signals with a larger number of tones may result in receiver devices having to perform additional processing on frames or data units (e.g., packet layer convergence protocol (PLCP) protocol data units (PPDUs)) than what is needed to handle legacy frames or data units that use fewer tones. The additional processing may cause the receiver devices to take more time to process and decode the data units. There is therefore a desire for improvements in wireless communications that accommodate for the added time consumed by those receiver devices processing data units for networks with greater data throughput.

SUMMARY

[0005] In one aspect, a method for signaling in wireless communications may include identifying a signal extension (SE) duration for a data unit from a set of at least five possible SE durations, using only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit, and outputting the data unit for transmission to the receiver.

[0006] In another aspect, an apparatus for signaling in wireless communications may include an SE duration identifier configured to identify an SE duration for a data unit from a set of at least five possible SE durations, a signaling bits setter configured to use only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit, and a communicator configured to output the data unit for transmission to the receiver.

[0007] In another aspect, an apparatus for signaling in wireless communications may include means for identifying an SE duration for a data unit from a set of at least five possible SE durations, means for using only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit, and means for outputting the data unit for transmission to the receiver.

[0008] In yet another aspect, a non-transitory computer-readable medium storing executable code for signaling in wireless communications may include code to identify an SE duration for a data unit from a set of at least five possible SE durations, code to use only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a

receiver of the data unit, and code to output the data unit for transmission to the receiver.

[0009] In another aspect, a method for signaling in wireless communications may include receiving a data unit from a transmitter device, identifying two signaling bits in the data unit that indicate an SE duration selected for the data unit, and using the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

[0010] In another aspect, an apparatus for signaling in wireless communications may include a communicator configured to receive a data unit from a transmitter device, a signaling bits identifier configured to identify two signaling bits in the data unit that indicate an SE duration selected for the data unit, and an SE duration determiner configured to use the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

[0011] In another aspect, an apparatus for signaling in wireless communications may include means for receiving a data unit from a transmitter device, means for identifying two signaling bits in the data unit that indicate an SE duration selected for the data unit, and means for using the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

[0012] In yet another aspect, a non-transitory computer-readable medium storing executable code for signaling in wireless communications may include code for receiving a data unit from a transmitter device, code for identifying two signaling bits in the data unit that indicate an SE duration selected for the data unit, and code for using the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

[0013] It is understood that other aspects of apparatuses and methods will become readily apparent to those skilled in the art from the following detailed description, wherein various aspects of apparatuses and methods are shown and described by way of illustration. As will be realized, these aspects may be implemented in other and different forms and its several details are capable of modification in various other respects. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not as restrictive

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Various aspects of apparatuses and methods will now be presented in the detailed description by way of example, and not by way of limitation, with reference to the accompanying drawings, wherein:

[0015] FIG. 1 is a conceptual diagram illustrating an example of a wireless local area network (WLAN) deployment;

[0016] FIG. 2 is a conceptual diagram illustrating an example of a signal extension scheme;

[0017] FIG. 3 is a conceptual diagram illustrating an example of signal extension signaling from a transmitter device to a receiver device;

[0018] FIG. 4 is a block diagram illustrating an example of a signal extension signaler in a transmitter device;

[0019] FIG. 5 is a block diagram illustrating an example of a signal extension signaler in a receiver device;

[0020] FIG. 6 is a flow diagram illustrating an example of a method for signal extension signaling by a transmitter device;

[0021] FIG. 7 is a flow diagram illustrating another example of a method for signal extension signaling by a transmitter device;

[0022] FIG. 8 is a flow diagram illustrating an example of a method for signal extension signaling by a receiver device;

[0023] FIG. 9 is a flow diagram illustrating another example of a method for signal extension signaling by a receiver device; and

[0024] FIG. 10 is a block diagram illustrating an example of a processing system that supports signal extension signaling operations.

DETAILED DESCRIPTION

[0025] Various concepts will be described more fully hereinafter with reference to the accompanying drawings. These concepts may, however, be embodied in many different forms by those skilled in the art and should not be construed as limited to any specific structure or function presented herein. Rather, these concepts are provided so that this disclosure will be thorough and complete, and will fully convey the scope of these concepts to those skilled in the art. The detailed description may include specific details. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring the various concepts presented throughout this disclosure.

[0026] The present disclosure provides various aspects related to techniques for signal extension signaling. To address the desire for greater data throughput using WLANs networks, the IEEE 802.11ax Wi-Fi standard uses a number of tones that is four (4) times the number of tones used in the legacy IEEE 802.11ac Wi-Fi standard. With a greater number of tones comes increased complexity at a receiver device processing data units having the larger number of tones. The receiver device, however, has to process a received data unit and generate a response to the received data unit under IEEE 802.11ax in the same amount of time as it would have under the legacy IEEE 802.11ac. That is, the receiver device has a turnaround time to generate a response (e.g., ACK, NACK, or other type of response) in IEEE 802.11ax of a short interframe space (SIFS) duration, or 16 microseconds (μs), even though it now has to process four times the number of tones.

[0027] To alleviate this additional processing complexity on the receiver device, signal extension (SE) schemes are generally being considered. The term "signal extension" may be used interchangeably with the term "frame extension" (or FE), however, the former will be used throughout this disclosure. Signal extension may refer to the extension of a duration of a data unit or frame by adding a waveform to the end of the data unit or frame (*see e.g.*, SE 230 in FIG. 2). By having a data unit extended or increased in this way, a receiver device can complete the processing and provide a response to an extended data unit within a SIFS duration in IEEE 802.11ax. In other words, the receiver device now has the duration of the signal extension in addition to the SIFS duration to perform the data unit processing and the generation of an appropriate response.

[0028] The determination of the scenarios in which signal extension is to be used for a data unit and by how much should the data unit be extended may be based, at least in part, on whether a modulation and coding scheme (MCS) exceeds a predetermined threshold and/or on a portion of useful bits in the last symbol of the data unit. Once it is determined that signal extension is to be used for a particular data unit and the amount or duration of the signal extension that is to be added to the end of the data unit, the transmitter device (e.g., an AP) needs to signal the signal extension information to the receiver device (e.g., an STA) for the receiver device to know how much of the received data is to be decoded (e.g., when to stop decoding the received data unit).

[0029] Some proposed signaling schemes for signal extension rely on a number of bits that provides enough resolution for the receiver device to figure out the exact duration of the signal extension applied by the transmitter device. For example, when there are five possible signal extension durations that can be applied to a data unit, one proposed signaling scheme uses three bits (e.g., eight distinct values) to clearly identify and signal to a receiver device which one of the five possible signal extension durations has been selected at the transmitter device for the particular data unit. Using fewer than three bits in this proposed scheme would not work because the number of distinct values would be less than five. For example, using two bits would only provide four distinct values and all five possible signal extension durations could not be signaled.

[0030] The present disclosure provides for a signaling scheme for signal extension that can use only two signaling bits to uniquely identify and signal to a receiver device which one of five possible signal extension durations has been selected at the transmitter device for a particular data unit. Using the two-bit scheme described in this disclosure instead of the proposed three-bit scheme described above can result in significant benefits. One reason is that signaling bits are included in a preamble of the data unit and the preamble is not transmitted at a high data rate in part to maintain compatibility with legacy devices. For example, the preamble in many cases is transmitted using the lowest MCS, with code rate of ½, using convolutional code, and using binary phase shift keying (BPSK) modulation. Moreover, in at least some implementations, multiple-input multiple-output (MIMO) and/or spatial multiplexing techniques are not used to transmit the preamble. Therefore, each additional bit in the preamble could potentially take up to several microseconds to be transmitted. Because a preamble is used with each data unit transmitted, even reducing the number of bits in the preamble by a single bit can result in significant improvements in transmission efficiency. Aspects of a two-bit scheme for signal extension signaling are described in more detail below.

[0031] **FIG. 1** is a conceptual diagram 100 illustrating an example of a wireless local area network (WLAN) deployment in connection with various techniques described herein for signal extension signaling. The WLAN may include one or more access points (APs) and one or more mobile stations (STAs) associated with a respective AP. In this example, there are two APs deployed: AP1 105-a in basic service set 1 (BSS1) and AP2 105-b in BSS2, which may referred to as an OBSS. AP1 105-a is shown having at least three associated STAs (STA1 115-a, STA2 115-b, and STA3 115-c) and coverage area 110-a, while AP2 105-b is shown having at least two associated STAs (STA2 115-b and STA4 115-d) and coverage area 110-b. In the example of FIG. 1, the coverage area of AP1 105-a overlaps part of the coverage area of AP2 105-b such that STA2 115-b is within the overlapping portion of the coverage areas. The number of BSSs, APs, and STAs, and the coverage areas of the APs described in connection with the WLAN deployment of FIG. 1 are provided by way of illustration and not of limitation. Moreover, aspects of the various techniques described herein for signal extension signaling may be based on at least portions of the WLAN deployment of FIG. 1.

[0032] The APs (e.g., AP1 105-a and AP2 105-b) shown in FIG. 1 are generally fixed terminals that provide backhaul services to STAs within its coverage area or region. In some applications, however, the AP may be a mobile or non-fixed terminal. The STAs (e.g., STA1 115-a, STA2 115-b, STA3 115-c, and STA4 115-d) shown in FIG. 1, which may be fixed, non-fixed, or mobile terminals, utilize the backhaul services of their respective AP to connect to a network, such as the Internet. Examples of an STA include, but are not limited to: a cellular phone, a smart phone, a laptop computer, a desktop computer, a personal digital assistant (PDA), a personal communication system (PCS) device, a personal information manager (PIM), personal navigation device (PND), a global positioning system, a multimedia device, a video device, an audio device, a device for the Internet-of-Things (IoT), or any other suitable wireless apparatus requiring the backhaul services of an AP. An STA may also be referred to by those skilled in the art as: a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communications device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless station, a remote terminal, a handset, a user agent, a mobile client, a client, user equipment (UE), or some other suitable terminology. An AP may also be referred to as: a base station, a base transceiver station, a radio base station, a radio transceiver, a transceiver function, or any other suitable terminology. The various concepts described throughout this disclosure are intended to apply to all suitable wireless apparatus regardless of their specific nomenclature.

[0033] Each of STA1 115-a, STA2 115-b, STA3 115-c, and STA4 115-d may be implemented with a protocol stack. The protocol stack can include a physical layer for transmitting and receiving data in accordance with the physical and electrical specifications of the wireless channel, a data link layer for managing access to the wireless channel, a network layer for managing source to destination data transfer, a transport layer for managing transparent transfer of data between end users, and any other layers necessary or desirable for establishing or supporting a connection to a network.

[0034] Each of AP1 105-a and AP2 105-b can include software applications and/or circuitry to enable associated STAs to connect to a network via communications links 125. The APs can send frames to their respective STAs and receive frames from their respective STAs to communicate data and/or control information (e.g., signaling).

[0035] Each of AP1 105-a and AP2 105-b can establish a communications link 125 with an STA that is within the coverage area of the AP. Communications links 125 can comprise communications channels that can enable both uplink and downlink communications. When connecting to an AP, an STA can first authenticate itself with the AP and then associate itself with the AP. Once associated, a communications link 125 can be established between the AP and the STA such that the AP and the associated STA can exchange frames or messages through a direct communications channel.

[0036] While aspects for performing signal extension signaling are described in connection with a WLAN deployment or the use of IEEE 802.11-compliant networks, those skilled in the art will readily appreciate, the various aspects described throughout this disclosure may be extended to other networks employing various standards or protocols including, by way of example, BLUETOOTH® (Bluetooth), HiperLAN (a set of wireless standards, comparable to the IEEE 802.11 standards, used primarily in Europe), and other technologies used in wide area networks (WAN)s, WLANs, personal area networks (PAN)s, or other suitable networks now known or later developed. Thus, the various aspects presented throughout this disclosure for signal extension signaling may be applicable to any suitable wireless network regardless of the coverage range and the wireless access protocols utilized.

[0037] **FIG. 2** is a conceptual diagram 200 illustrating an example of a signal extension scheme. As noted above, signal extension or SE may be used to alleviate the processing burden that comes when a receiver device has to process a greater number of tones in IEEE 802.11ax compared to the number of tones in legacy IEEE 802.11ac operations. The signal extension is implemented by, for example, adding a waveform 230 to the end of a data unit or frame 210. The signal extension can take several values (i.e., can have different durations). In the example of FIG. 2, there are shown five possible signal extension durations or values associated with the five data units shown. From the top data unit to the bottom data units these signal extension values or durations are, respectively: 0

μs, 4 μs, 8 μs, 12 μs, and 16 μs. Other implementations may use more than five possible signal extension durations, and/or may use signal extension durations that vary from the values shown in FIG. 2. The signal extension added to a data unit is different from the MAC/PHY padding applied as part of the encoding process. Moreover, the signal extension added to a data unit is also different from the additional or extra padding bits that are added to useful bits in the last symbol of the data unit as a filler.

[0038] In the bottom data unit shown in FIG. 2, a receiver device will now have as much as 32 μs (e.g., 16 μs from signal extension and 16 μs from SIFS) to complete the processing of a received data unit and to generate any response triggered by the data unit. This amount of time should now be sufficient in view of improved receiver processing capabilities for IEEE 802.11ax-compatible receiver devices.

[0039] As noted above, once it is determined that signal extension is to be used for a particular data unit and the amount or duration of the signal extension that is to be added to the end of the data unit, a transmitter device needs to signal the signal extension information to the receiver device for the receiver device to know how when to stop decoding the received data unit.

[0040] **FIG. 3** is a conceptual diagram 300 illustrating an example of signal extension signaling from a transmitter device 310 to a receiver device 320. In one example based on the WLAN deployment of FIG. 1, the transmitter device 310 can be AP1 105-a and the receiver device 320 can be the STA1 115-a. In this example, the AP1 105-a determines that signal extension is to be applied to a data unit (e.g., data unit 330) and the duration of the signal extension to be applied. The AP1 105-a then signals (e.g., using a communications link 125) the signal extension to the STA1 115-a using the two-bit signaling scheme described herein. The STA1 115-a may then decode the data unit by first identifying the signal extension applied from the signaling provided by the AP1 105-a.

[0041] In another example on the WLAN deployment of FIG. 1, the transmitter device 310 can be the STA1 115-a FIG. 1 and the receiver device 320 can be the STA3 115-c of FIG. 1, which are in a device-to-device communication configuration. In this example, the STA1 115-a determines that signal extension is to be applied to a data unit (e.g., data unit 330) and the duration of the signal extension to be applied. The STA1 115-a then signals (e.g., using a device-to-device communications link 127) the signal extension to the STA3 115-c using the two-bit signaling scheme described herein. The STA3 115-c may then decode the data unit by first identifying the signal extension applied from the signaling provided by the STA1 115-a.

[0042] The value of the duration of the data unit 330 in number of bytes is determined by the transmitter device 310 based on the time duration of the data unit 330 (TXTIME). At the transmitter device (e.g., AP1 105-a or STA1 115-a), the duration of the data unit 330 (e.g., physical layer convergence protocol (PLCP) data unit (PPDU)) is included in a Length field (L_{LENGTH}) of a legacy signal (L-SIG) field of a legacy preamble 335 of the data unit 330. The duration of the data unit 330, in number of bytes, is determined by the following expression (Equation 1):

$$L_{LENGTH} = \left\lceil \frac{TXTIME-20}{4} \right\rceil \times 3 - 3 + m \text{ where } m = 1, 2$$

where TXTIME = $T_{L\_PREAMBLE}$ + $T_{HE\_PREAMBLE}$ + T_{DATA} + T_{SE}. $T_{L\_PREAMBLE}$ is the duration of the legacy preamble 335 of the data unit 330 and includes a legacy short training field (L-STF), a legacy long training field (L-LTF), and L-SIG. $T_{HE\_PREAMBLE}$ is the duration of the high efficiency (HE) or IEEE 802.11ax preamble 340 of the data unit 330 and includes an RL-SIG, an HE-SIG-A, an HE-

SIG-B, an HE-STF, and an HE-LTF. The value *m* shown above has been added in IEEE 802.11ax to ensure that L_{LENGTH} is not exactly a multiple of 3 and is therefore used to distinguish between IEEE 802.11ax and IEEE 802.11ac transmissions. Equation 1 above uses a ceiling function with respect to TXTIME – 20 / 4. In an example, if a number is 3.4, the ceiling function rounds the number up to 4. The value of T_{DATA} is the duration of the data portion 345 of the data unit 330 and can be determined by the transmitter device 310 based on the following expression (Equation 2):

$$T_{DATA} = N_{sym} \times T_{sym} = N_{sym} \times (12.8 + T_{GI})$$

where N_{sym} is the number of data symbols, T_{sym} is the duration of a data symbol, and T_{GI} is the guard time of a data symbol, which can take the values of 0.8 µs, 1.6 µs, or 3.2 µs. As such, the data symbol duration can be 13.6 µs (12.8 µs + 0.8 µs), 14.4 µs (12.8 µs + 1.6 µs), or 16 µs (12.8 µs + 3.2 µs). Finally, T_{SE} is the duration of the of the signal extension 350 and can take the values within a set of signal extension durations that include, for example, 0 µs, 4 µs, 8 µs, 12 µs, and 16 µs.

[0043] In IEEE 802.11ac, the reason that the transmitter device 310 provides L_{LENGTH} and TXTIME is for the receiver device 320 to know the number of data symbols (N_{sym}) that need to be decoded. In IEEE 802.11ax, for the receiver device 320 to know the number of data symbols (N_{sym}) to be decoded, the transmitter device 310 may provide L_{LENGTH}, TXTIME, and T_{SE}.

[0044] The transmitter device 310 may be configured to communicate the duration of the signal extension 350 (e.g., T_{SE}) to the receiver device 320 by using two signaling bits 355 in the HE-SIG-A or HE-SIG-B field of the high efficiency preamble 340. This approach is valid for both single user and multi-user cases. Alternatively, the two signaling bits 355 may be included in another location of the data unit 330. By using only two signaling bits 355, it is possible to convey to the receiver device 320 that signal extension is either present or absent (e.g., signal extension duration of 0 µs), and if present, whether the signal extension takes values in a first subset of the set of signal extension durations (e.g., 4 µs, 8 µs, and 12 µs), or takes values in a second subset of the set of signal extension durations (e.g., 12 µs and 16 µs). Based on these two bits (e.g., the only two bits devoted to signal extension signaling), and other information available to the receiver of the data unit 330, the receiver is able to uniquely determine which value of the five or more possible values is used for the signal extension portion 350 of the data unit 330.

[0045] The signal extension information can be conveyed to the receiver device 320 using only two signaling bits 355 by having a first signaling bit (referred to as bit x) of the two signaling bits 355 indicate whether signal extension is either present or absent, and by having a second signaling bit (referred to as bit y) of the two signaling bits 355 indicate that the signal extension is either in the first subset of the set of signal extension durations (e.g., 4 µs, 8 µs, and 12 µs) or in the second subset of the set of signal extension durations (e.g., 12 µs and 16 µs).

[0046] For example, Table 1 below illustrates one implementation of a system that uses two bits to convey signal extension information to the receiver device 320:

BITS (x,y)	**INDICATION**
00	SE is absent
01	SE is absent

10	SE is present and in the subset {4 μs, 8 μs, and 12 μs}
11	SE is present and in the subset {12 μs and 16 μs}

Table 1. Signal Extension Indication Based on 2-Bit Signaling.

[0047] Alternatively, Table 2 below illustrates a different implementation of a system that uses two bits to convey signal extension information to the receiver device 320:

BITS (x,y)	INDICATION
00	SE is absent
01	SE is present and in the subset {4 μs, 8 μs, and 12 μs}
10	SE is present and in the subset {12 μs and 16 μs}
11	Reserved

Table 2. Signal Extension Indication Based on 2-Bit Signaling.

where the bit pairing "11" may be reserved for other aspects. In one example, the bit pairing "11" may be used for signaling additional groups or for signaling additional information to the receiver device 320.

[0048] The transmitter 310 may be configured to set or determine the two signaling bits 355 as follows. In an example, if the signal extension is present (e.g., signal extension is to be applied to a data unit), then the transmitter 310 sets the first signaling bit (e.g., bit x) to 1, otherwise the first signaling bit is set to 0. If the signal extension is present and the following condition (Equation 3) is TRUE,

$$\frac{1}{T_{sym}}\left[T_{SE}+4\times\left(\left\lceil\frac{TXTIME}{4}\right\rceil-\left(\frac{TXTIME}{4}\right)\right)\right]\geq 1$$

or

$$T_{SE}+4\times\left(\left\lceil\frac{TXTIME}{4}\right\rceil-\left(\frac{TXTIME}{4}\right)\right)\geq T_{sym}$$

then the transmitter 310 sets the second signaling bit (e.g., bit y) to 1, otherwise the second signaling bit is set to 0. It is to be understood that these bit values are provided by way of illustration and other value assignments may also be used. Once the two signaling bits 355 have been set according to the scheme described above, the transmitter device 310 may include the two signaling bits 355 in, for example, the HE-SIG-A or HE-SIG-B field in the high efficiency preamble 340 of the data unit 330, and may send or transmit the data unit 330 to the receiver device 320 for decoding.

[0049] The time duration of the data unit 330 is determined by the receiver device 320 based on the duration of the data unit 330 in number of bytes (LLENGTH). That is, at the receiver device 320, the duration RXTIME of the data unit 330 is computed from LLENGTH in the L-SIG as follows (Equation 4):

$$RXTIME=\left\lceil\frac{L_{LENGTH}+3}{3}\right\rceil\times 4+20$$

[0050] Once the RXTIME is known, the number of data symbols is computed or determined by the receiver device 320 using a two-step process. In a first step or operation of the two-step process, the receiver device 320 computes or determines a first number of data symbols, N'_{sym}, using the following expression (Equation 5):

$$N'_{sym} = \left\lfloor \frac{RXTIME - T_{L\_PREAMBLE} - T_{HE\_PREAMBLE}}{T_{sym}} \right\rfloor$$

Equation 5 above uses a flooring function to obtain N'_{sym}. In an example, if a number is 3.4, the flooring function rounds the number down to 3. In a second step or operation of the two-step processes, the receiver device 320 identifies the two signaling bits 355 from the data unit 330 and computes or determines a second number of data symbols, N_{sym}, using the two signaling bits 355 as follows (Equation 6):

- If x = 0, then $N_{sym} = N'_{sym}$
- If x = 1 and y=0, then $N_{sym} = N'_{sym}$
- If x = 1 and y=1, then $N_{sym} = N'_{sym} - 1$

After N_{sym} is obtained, the duration (e.g., T_{SE}) of the signal extension 350 applied to the data unit 330 is determined or computed by the receiver device 320 based on the following expression (Equation 7):

$$T_{SE} = \left\lfloor \frac{RXTIME - T_{L\_PREAMBLE} - T_{HE\_PREAMBLE} - (N_{sym} \times T_{sym})}{4} \right\rfloor \times 4$$

Once T_{SE} is known by the receiver device 320, the data unit 330 can be decoded because the receiver device 320 knows precisely where it needs to stop the decoding.

[0051] **FIG. 4** is a block diagram 400 illustrating an example of an SE signaler 410 in the transmitter device 310. The SE signaler 410 may include an SE duration identifier 420 configured to identify or select an SE duration 423 (e.g., T_{SE}) for a data unit when signal extension is to be applied to the data unit. The SE duration 423 may be identified or selected from a set of possible SE durations 422. The set of possible SE durations 422 may include at least five possible SE durations. In one example, the set of possible SE durations 422 includes a set of five possible SE durations of 0 µs, 4 µs, 8 µs, 12 µs, and 16 µs. In this example, the set of five possible SE durations may include a first subset having SE durations of 4 µs, 8 µs, and 12 µs, and a second subset having SE durations of 12 µs and 16 µs.

[0052] The SE signaler 410 may include a signaling bits setter 425 configured to set a value of a first signaling bit 435 (e.g., bit x of the two signaling bits 355 in FIG. 3) and to set a value of a second signaling bit 440 (e.g., bit y of the two signaling bits 355 in FIG. 3). The SE signaler 410 may use preamble/data information 430 to set the first signaling bit 435 and the second signaling bit 440. The preamble/data information 430 may include, but need not be limited to, TXTIME, T_{SE} (e.g., SE duration 423 from the SE duration identifier 420), and T_{sym}.

[0053] The SE signaler 410 may include a frame/data unit modifier 445 configured to modify a data unit (e.g., data unit 330 in FIG. 3) to add a signal extension (e.g., signal extension 350), and to include the first signaling bit 435 and the second signaling bit 440 (e.g., two signaling bits 355) into an HE-SIG-A or HE-SIG-B field of the data unit.

[0054] The SE signaler 410 may include a frame/data unit communicator 450 configured to output a data unit modified by the frame/data unit modifier 445, where the modified data unit is output for transmission to a receiver device (e.g., the receiver device 320 in FIG. 3).

[0055] **FIG. 5** is a block diagram 500 illustrating an example of an SE signaler 510 in the receiver device 320. The SE signaler 510 may include a frame/data unit communicator 520 configured to receive a data unit (e.g., the data unit 330 in FIG. 3) from a transmitter device (e.g., the transmitter device 310 in FIG. 3).

[0056] The SE signaler 510 may include a signaling bits identifier 530 configured to identify a first signaling bit 535 (e.g., bit x of the two signaling bits 355 in FIG. 3) and a second signaling bit 540 (e.g., bit y of the two signaling bits 355 in FIG. 3) from the data unit received by the frame/data unit communicator 520. The first signaling bit 535 and the second signaling bit 540 may be identified from an HE-SIG-A or HE-SIG-B field.

[0057] The SE signaler 510 may include an SE duration determiner 545 configured to use the first signaling bit 535 and the second signaling bit 540 to determine which SE duration 560 from a set of possible SE durations has been selected and applied to the data unit by the transmitter device. The SE duration determiner 545 may include a data symbol determiner 555 configured to determine a first number of data symbols, and then determine a second number of data symbols based on the first signaling bit 535 and the second signaling bit 540, where the second number of data symbols is used to determine the SE duration 560 (e.g., T_{SE}). The data symbol determiner 555 is further configured to determine the first number of data symbols based at least in part on preamble/data information 550 (e.g., RXTIME, $T_{L\_PREAMBLE}$, $T_{HE\_PREAMBLE}$, and T_{sym}).

[0058] The SE signaler 510 may include a frame/data unit decoder 565 configured to decode the data unit received by the frame/data unit communicator 520 based at least in part on the SE duration 560 (e.g., T_{SE}) determined by the SE duration determiner 545.

[0059] The various elements, components, or modules described above with respect to the transmitter device 310 in FIG. 4 and the receiver device 320 in FIG. 5 may be implemented in hardware, software, or a combination of hardware and software. For example, at least a portion of the functionality of each of the various elements, components, or modules described above with respect to the transmitter device 310 in FIG. 4 and the receiver device 320 in FIG. 5 can be implemented or performed by a processor (see e.g., processor 1004 in FIG. 10) in connection with instructions or code stored in and/or provided by a computer readable medium or memory (see e.g., computer-readable medium 1006 in FIG. 10). The instructions or code may be programmed to implement the methods shown in FIGS. 6-9 and described herein, such as through use of the equations and functionality for setting SE duration indicating bits and/or determining the intended SE duration from the SE duration indicating bits. Moreover, values, parameters, and/or different types of information handled by the transmitter device 310 in FIG. 4 and the receiver device 320 in FIG. 5 may be stored in local memory to the elements, components, or modules of the transmitter device 310 and the receiver device 320, and/or in other memory such as the computer-readable medium 1006 in FIG. 10.

[0060] **FIG. 6** is a flow diagram illustrating an example of a method 600 for signal extension signaling by a transmitter device (e.g., the transmitter device 310 in FIGS. 3 and 4). At 610, a signal extension duration for a data unit is identified from a set of at least five possible SE durations. In an example, the SE duration identifier 420 in the SE signaler 410 (FIG. 4) may identify an SE duration 423 from a set of possible SE durations 422.

[0061] At 615, two signaling bits in the data unit may be used to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit. In an example, the signaling bits setter 425 in the SE signaler 410 (FIG. 4) may be used to set two signaling bits (e.g., the first signaling bit 435 and the second signaling bit 440) to indicate the SE duration 423 identified by the SE duration identifier 420. The signaling bits setter 425 may perform or execute one or more of Equations 1, 2, and 3 and may access information from one or both of Tables 1 and 2 in order to set the two signaling bits.

[0062] At 620, the data unit is output for transmission to the receiver. In an example, the frame/data unit communicator 450 in the SE signaler 410 (FIG. 4) outputs a data unit modified by the frame/data unit modifier 445 to include a signal extension added to the end of the data unit and the two signaling bits that indicate the signal extension.

[0063] In another aspect of the method 600, the set of at least five possible SE durations includes only five possible SE durations, and the set of five possible SE durations includes durations of 0 μs, 4 μs, 8 μs, 12 μs, and 16 μs.

[0064] In another aspect of the method 600, the two signaling bits are included in an HE-SIG-A or HE-SIG-B field of a high efficiency preamble (e.g., preamble 340) associated with the data unit (e.g., data unit 330).

[0065] In another aspect of the method 600, using only two signaling bits to indicate the identified SE duration includes setting the two signaling bits to a first value pair to indicate that the SE duration is 0 μs, setting the two signaling bits to a second value pair to indicate that the SE duration is part of a first subset of the set of at least five possible SE durations, or setting the two signaling bits to a third value pair to indicate that the SE duration is part of a second subset of the set of at least five possible SE durations. In another aspect, at least one possible SE duration value (e.g., 12 μs) of the at least five possible SE durations is included in both the first subset and the second subset.

[0066] **FIG. 7** is a flow diagram illustrating an example of a method 700 for signal extension signaling by a transmitter device (e.g., the transmitter device 310 of FIGS. 3 and 4). The method 700 may provide additional details associated with the use of two signaling bits in 615 of FIG. 6, which may be performed by, for example, the signaling bit setter 425 of the SE signaler 410 (FIG. 4). The signaling bits setter 425 may perform or execute one or more of Equations 1, 2, and 3 and may access information from one or both of Tables 1 and 2 in order to set the two signaling bits.

[0067] At 710, a first signaling bit of the two signaling bits is set to a first value to indicate that the SE duration is 0 μs, or to a second value to indicate that the SE duration is greater than 0 μs.

[0068] At 715, a second signaling bit of the two signaling bits is set to a first value to indicate that the SE duration is part of a first subset of the set of at least five possible SE durations, or to a second value to indicate that the SE duration is part of a second subset of the set of at least five possible SE durations.

[0069] In an aspect of method 700, the first subset may include SE durations of 4 μs, 8 μs, and 12 μs, and the second subset may include SE durations of 12 μs and 16 μs.

[0070] **FIG. 8** is a flow diagram illustrating an example of a method 800 for signal extension signaling by a receiver device (e.g., the receiver device 320 in FIGS. 3 and 5). At 810, a data unit is receiver from a transmitter device. In an example, the frame/data unit communicator 520 in the SE signaler 510 receives a data unit from a transmitter device (e.g., the transmitter device 310 in FIGS. 3 and 4).

[0071] At 815, two signaling bits are identified in the data unit and are used to indicate a signal extension duration for the data unit. In an example, the signaling bits identifier 530 in the SE signaler 510 (FIG. 5) identifies the first signaling bit 535 and the second signaling bit 540 from a data unit received by the frame/data unit communicator 520.

[0072] At 820, the two signaling bits are used to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit. In one example, the SE duration determiner 545 in the SE signaler 510 (FIG. 5) determines the SE duration 560 based at least in part on the first signaling bit 535 and the second signaling bit 540 identified by the signaling bits identifier 530.

[0073] In another aspect of the method 800, the set of at least five possible SE durations includes only five possible SE durations, and the set of five possible SE durations includes durations of 0 µs, 4 µs, 8 µs, 12 µs, and 16 µs.

[0074] In another aspect of the method 800, the two signaling bits are included in an HE-SIG-A or HE-SIG-B field of a high efficiency preamble (e.g., high efficiency preamble 340) associated with the data unit (e.g., data unit 330).

[0075] **FIG. 9** is a flow diagram illustrating an example of a method 900 for signal extension signaling by a receiver device (e.g., the receiver device in FIGS. 3 and 5). The method 900 may provide additional details associated with determining the SE duration in 815 in FIG. 8, which may be performed by, for example, the SE duration determiner 545 and/or the data symbol determiner 555 of the SE signaler 510 (FIG. 5).

[0076] At 910, a first number of data symbols (e.g., N'_{sym}) is determined for the data unit (e.g., using one or both of Equations 4 and 5 above).

[0077] At 915, a second number of data symbols (e.g., N_{sym}) is determined for the data unit based on the first number of data symbols and the two signaling bits (e.g., the first signaling bit 535 and the second signaling bit 540 in FIG. 5). The second number of data symbols may be determined using Equation 6 above.

[0078] At 920, the SE duration (e.g., SE duration 560 in FIG. 5) is determined based at least in part on the second number of data symbols (e.g., using Equation 7 above) .

[0079] **FIG. 10** shows a block diagram 1000 illustrating an example of a processing system 1014 that supports signal extension signaling operations. The processing system 1014 may be implemented with a bus architecture, represented generally by the bus 1002. The bus 1002 may include any number of interconnecting buses and bridges depending on the specific application of the processing system 1014 and the overall design constraints. The bus 1002 links together various circuits including one or more processors and/or hardware modules, represented by a processor 1004, an SE signaler 410/510, and a computer-readable medium / memory 1006. The bus 1002 may also link various other circuits such as timing sources, peripherals, voltage regulators, and power management circuits, which are well known in the art, and therefore, will not be described any further.

[0080] The processing system 1014 may be coupled to a transceiver 1010 via an interface 1008. The transceiver 1010 is coupled to one or more antennas 1020. The transceiver 1010 may provide a means for communicating with various other apparatus or devices over a transmission medium. The transceiver 1010 may receive a signal from the one or more antennas 1020, may extract information from the received signal, and may provide the extracted information to the processing system 1614, specifically the processor 1004 and/or the SE signaler 410/510. In addition, the transceiver 1010 may receive information from the processing system 1014 and/or the SE signaler 410/510, and based on the received information, may generate a signal to be applied to the one or more antennas 1020. The processing system 1014 includes the processor 1004 coupled to the computer-readable medium / memory 1006, and/or to the SE signaler 410/510, which may be the SE signaler 410 (FIG. 4) when the processing system 1014 is part of a transmitter device and the SE signaler 510 (FIG. 5) when the processing system 1014 is part of a receiver device. The processor 1004 is responsible for general processing, including the execution of software stored on the computer-readable medium / memory 1006. The software, when executed by the processor 1004, causes the processing system 1014 to perform the various functions described in the disclosure for signal extension signaling. The computer-readable medium / memory 1006 may also be used for storing data that is manipulated by the processor 1004 when executing software. The SE signaler 410/510 may be a software module running in the processor 1004, resident/stored in the computer readable medium / memory 1006, a hardware module coupled to the processor 1004, or some combination thereof. In some instances, the processor 1004 and the computer readable medium / memory 1006 may be used to perform functions, operations, or features described herein with respect to one or more of the components of the SE signaler 410 (FIG. 4) or the SE signaler 510 (FIG. 5).

[0081] The apparatus and methods have been described in the detailed description and illustrated in the accompanying drawings by various elements comprising blocks, modules, components, circuits, steps, processes, algorithms, and the like. These elements, or any portion thereof, either alone or in combinations with other elements and/or functions, may be implemented using electronic hardware, computer software, or any combination thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. In an aspect, the term "component" as used herein may be one of the parts that make up a system and may be divided into other components.

[0082] By way of example, an element, or any portion of an element, or any combination of elements may be implemented with a "processing system" that includes one or more processors. A processor may include a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic component, discrete gate or transistor logic, discrete hardware components, or any combination thereof, or any other suitable component designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing components, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP, or any other such configuration.

[0083] One or more processors in the processing system may execute software. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. The software may reside on transitory or non-transitory computer-readable medium. A non-transitory computer-readable medium may include, by way of example, a magnetic storage device (e.g., hard disk, floppy disk, magnetic strip), an optical disk (e.g., compact disk (CD), digital versatile disk (DVD)), a smart card, a flash memory device (e.g., card, stick, key drive), random access memory (RAM), static RAM (SRAM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM); double date rate RAM (DDRAM), read only memory (ROM), programmable ROM (PROM), erasable PROM (EPROM), electrically erasable PROM (EEPROM), a general register, or any other suitable non-transitory medium for storing software.

[0084] The various interconnections within a processing system may be shown as buses or as single signal lines. Each of the buses may alternatively be a single signal line, and each of the single signal lines may alternatively be buses, and a single line or bus might represent any one or more of a myriad of physical or logical mechanisms for communication between elements. Any of the signals provided over various buses described herein may be time-multiplexed with other signals and provided over one or more common buses.

[0100] The various aspects of this disclosure are provided to enable one of ordinary skill in the art to practice the present invention. Various modifications to examples of implementations presented throughout this disclosure will be readily apparent to those skilled in the art, and the concepts disclosed herein may be extended to other magnetic storage devices. Thus, the claims are not intended to be limited to the various aspects of this disclosure, but are to be accorded the full scope consistent with the language of the claims. All structural and functional equivalents to the various components of the examples of implementations described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 U.S.C. §112 (f), unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited using the phrase "step for."

WHAT IS CLAIMED IS:

1. A method for signaling in wireless communications, comprising:

identifying a signal extension (SE) duration for a data unit from a set of at least five possible SE durations;

using only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit; and

outputting the data unit for transmission to the receiver.

2. The method of claim 1, wherein the set of at least five possible SE durations includes only five possible SE durations, and wherein the set of five possible SE durations includes durations of 0 µs, 4 µs, 8 µs, 12 µs, and 16 µs.

3. The method of claim 1, wherein using only two signaling bits to indicate the identified SE duration comprises:

setting a first signaling bit of the two signaling bits to a first value to indicate that the SE duration is 0 µs, or to a second value to indicate that the SE duration is greater than 0 µs; and

setting a second signaling bit of the two signaling bits to a first value to indicate that the SE duration is part of a first subset of the set of at least five possible SE durations, or to a second value to indicate that the SE duration is part of a second subset of the set of at least five possible SE durations.

4. The method of claim 1, wherein using only two signaling bits to indicate the identified SE duration comprises:

setting the two signaling bits to a first value pair to indicate that the SE duration is 0 μs;

setting the two signaling bits to a second value pair to indicate that the SE duration is part of a first subset of the set of at least five possible SE durations; or

setting the two signaling bits to a third value pair to indicate that the SE duration is part of a second subset of the set of at least five possible SE durations.

5. The method of claim 4, wherein at least one possible SE duration value of the at least five possible SE durations is included in both the first subset and the second subset.

6. The method of claim 3, wherein the first subset includes SE durations of 4 μs, 8 μs, and 12 μs, and wherein the second subset includes SE durations of 12 μs and 16 μs.

7. The method of claim 1, wherein the two signaling bits are included in an HE-SIG-A or an HE-SIG-B field of a high efficiency preamble associated with the data unit.

8. A method for signaling in wireless communications, comprising:

receiving a data unit from a transmitter device;

identifying two signaling bits in the data unit that indicate a signal extension (SE) duration selected for the data unit; and

using the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

9. The method of claim 8, wherein using the two signaling bits to determine the SE duration comprises:

determining a first number of data symbols for the data unit;

determining a second number of data symbols for the data unit based on the first number of data symbols and the two signaling bits; and

determining the SE duration based at least in part on the second number of data symbols.

10. The method of claim 8, wherein the set of at least five possible SE durations includes only five possible SE durations, and wherein the set of five possible SE durations includes durations of 0 µs, 4 µs, 8 µs, 12 µs, and 16 µs.

11. The method of claim 8, wherein the two signaling bits are included in an HE-SIG-A or an HE-SIG-B field of a high efficiency preamble associated with the data unit.

12. An apparatus for signaling in wireless communications, comprising:

a signal extension (SE) duration identifier configured to identify an SE duration for a data unit from a set of at least five possible SE durations;

a signaling bits setter configured to use only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit; and

a communicator configured to output the data unit for transmission to the receiver.

13. An apparatus for signaling in wireless communications, comprising:

a memory that stores signal extension signaling instructions; and

a processor coupled with the memory and configured to execute the signal extension signaling instructions to:

identify a signal extension (SE) duration for a data unit from a set of at least five possible SE durations;

use only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit; and

output the data unit for transmission to the receiver.

14. An apparatus for signaling in wireless communications, comprising:

means for identifying a signal extension (SE) duration for a data unit from a set of at least five possible SE durations;

means for using only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit; and

means for outputting the data unit for transmission to the receiver.

15. A computer-readable medium storing executable code for signaling in wireless communications, comprising:

code to identify a signal extension (SE) duration for a data unit from a set of at least five possible SE durations;

code to use only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit; and

code to output the data unit for transmission to the receiver.

16. An apparatus for signaling in wireless communications, comprising:

a communicator configured to receive a data unit from a transmitter device;

a signaling bits identifier configured to identify two signaling bits in the data unit that indicate a signal extension (SE) duration selected for the data unit; and

an SE duration determiner configured to use the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

17. An apparatus for signaling in wireless communications, comprising:

a memory that stores signal extension signaling instructions; and

a processor coupled with the memory and configured to execute the signal extension signaling instructions to:

receive a data unit from a transmitter device;

identify two signaling bits in the data unit that indicate a signal extension (SE) duration selected for the data unit; and

use the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

18. An apparatus for signaling in wireless communications, comprising:

means for receiving a data unit from a transmitter device;

means for identifying two signaling bits in the data unit that indicate a signal extension (SE) duration selected for the data unit; and

means for using the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

19. A computer-readable medium storing executable code for signaling in wireless communications, comprising:

code for receiving a data unit from a transmitter device;

code for identifying two signaling bits in the data unit that indicate a signal extension (SE) duration selected for the data unit; and code for using the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

ABSTRACT

Various aspects are provided related to techniques for signal extension (SE) signaling. In one aspect, a method for signaling at a transmitter device includes identifying an SE duration for a data unit from a set of at least five possible SE durations, using only two signaling bits for the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit, and outputting the data unit for transmission to the receiver. In another aspect, a method for signaling at a receiver device includes receiving a data unit from a transmitter device, identifying two signaling bits in the data unit that indicate an SE duration selected for the data unit, and using the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit.

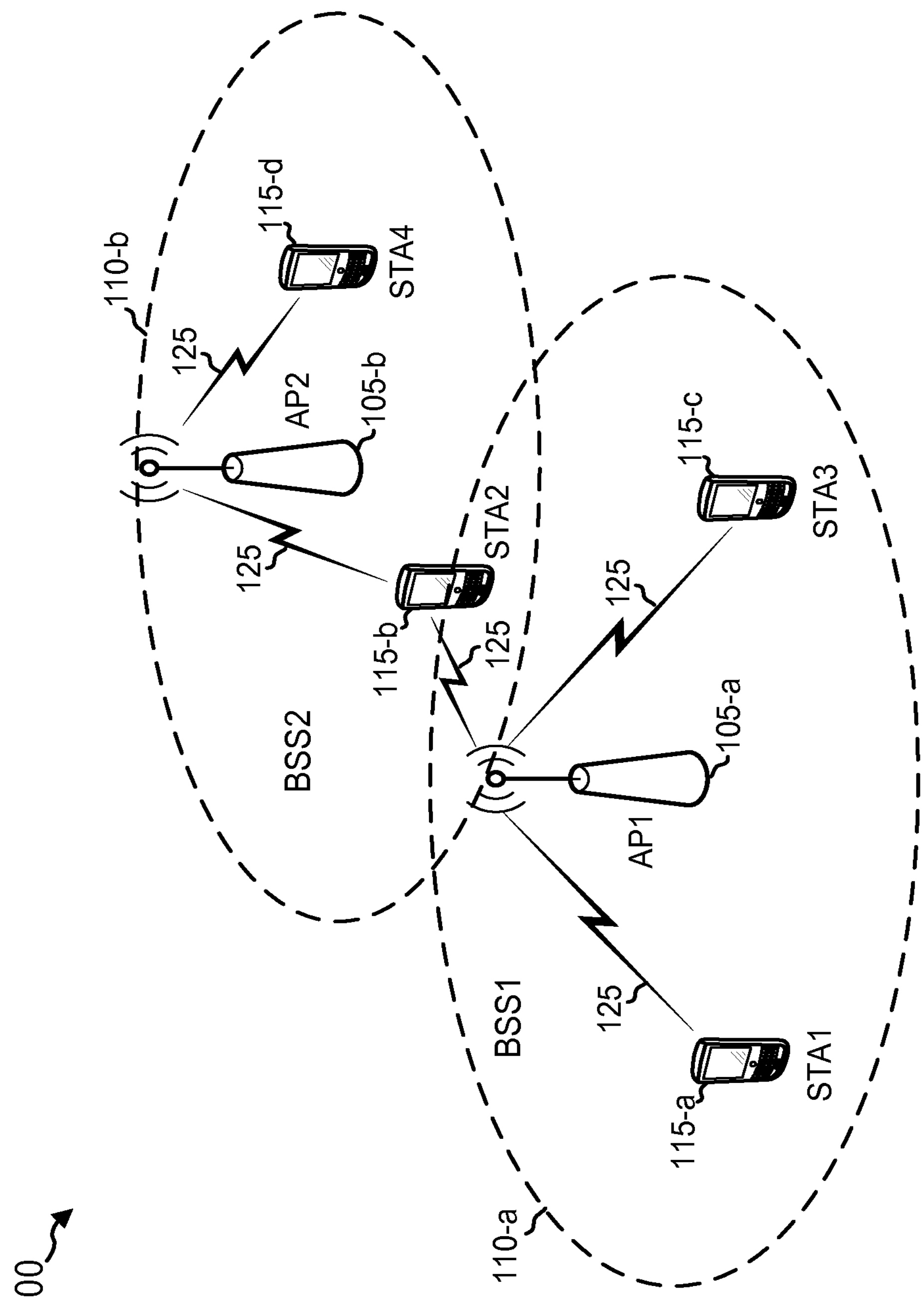
100
110-a
110-b
BSS1
BSS2
AP1
AP2
105-a
105-b
STA1
STA2
STA3
STA4
115-a
115-b
115-c
115-d
125

FIG. 1

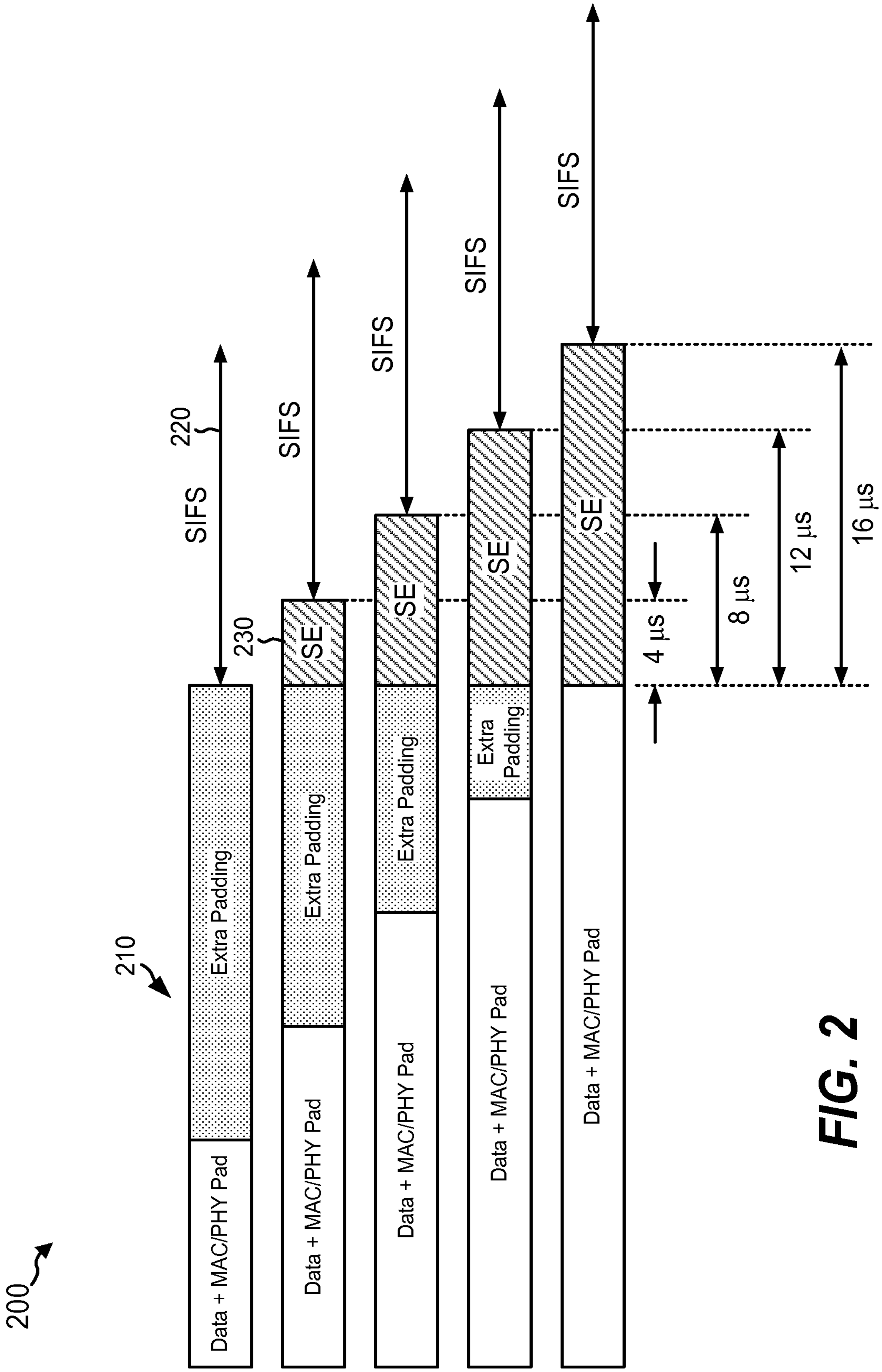
200
210
220
230
SIFS
SIFS
SIFS
SIFS
SIFS
SE
SE
SE
SE
Extra Padding
Extra Padding
Extra Padding
Extra Padding
Data + MAC/PHY Pad
Data + MAC/PHY Pad
Data + MAC/PHY Pad
Data + MAC/PHY Pad
Data + MAC/PHY Pad
4 μs
8 μs
12 μs
16 μs

FIG. 2

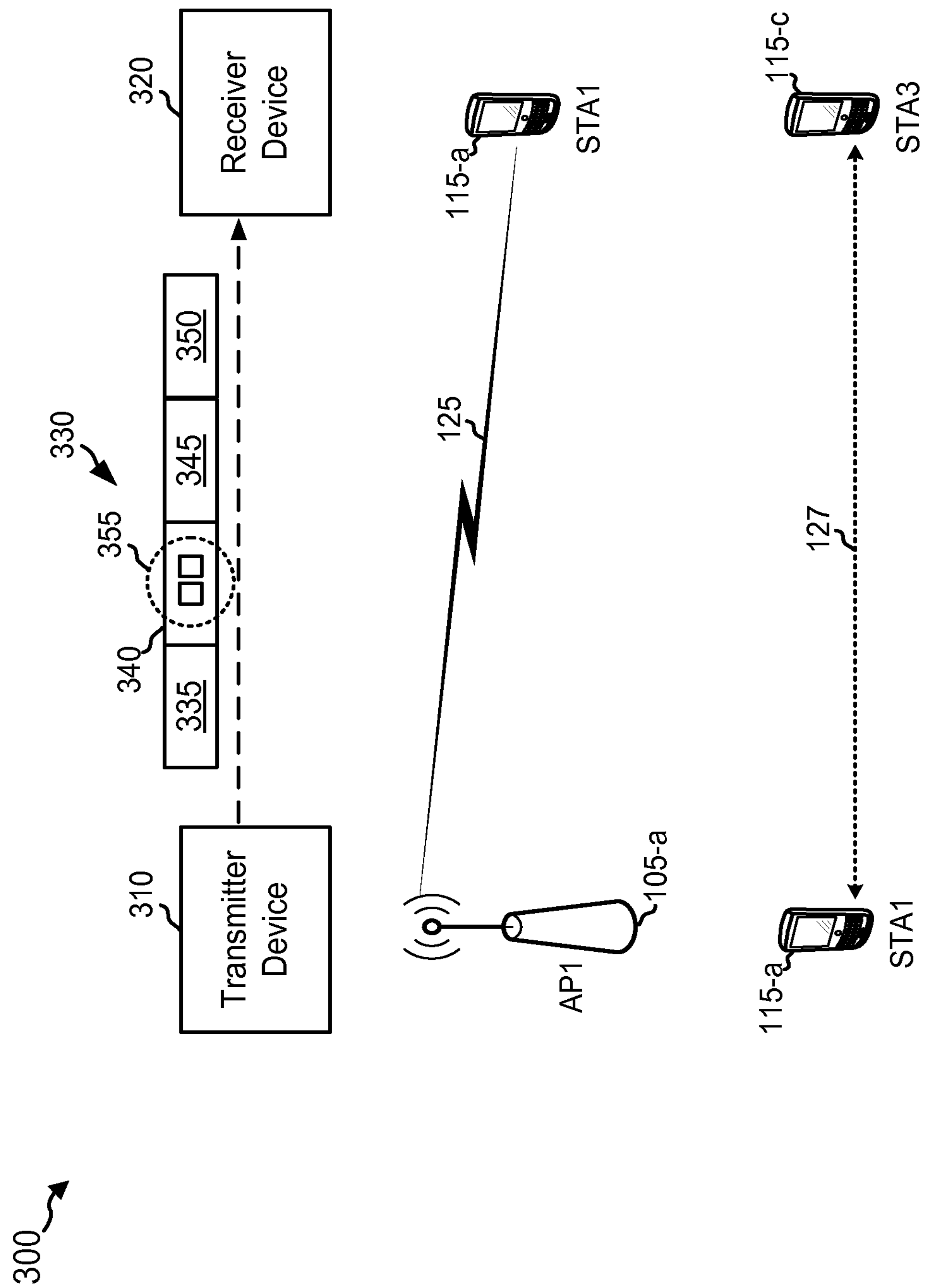
300
310
Transmitter Device
330
335
340
355
345
350
320
Receiver Device
AP1
105-a
125
115-a
STA1
115-a
STA1
127
115-c
STA3

FIG. 3

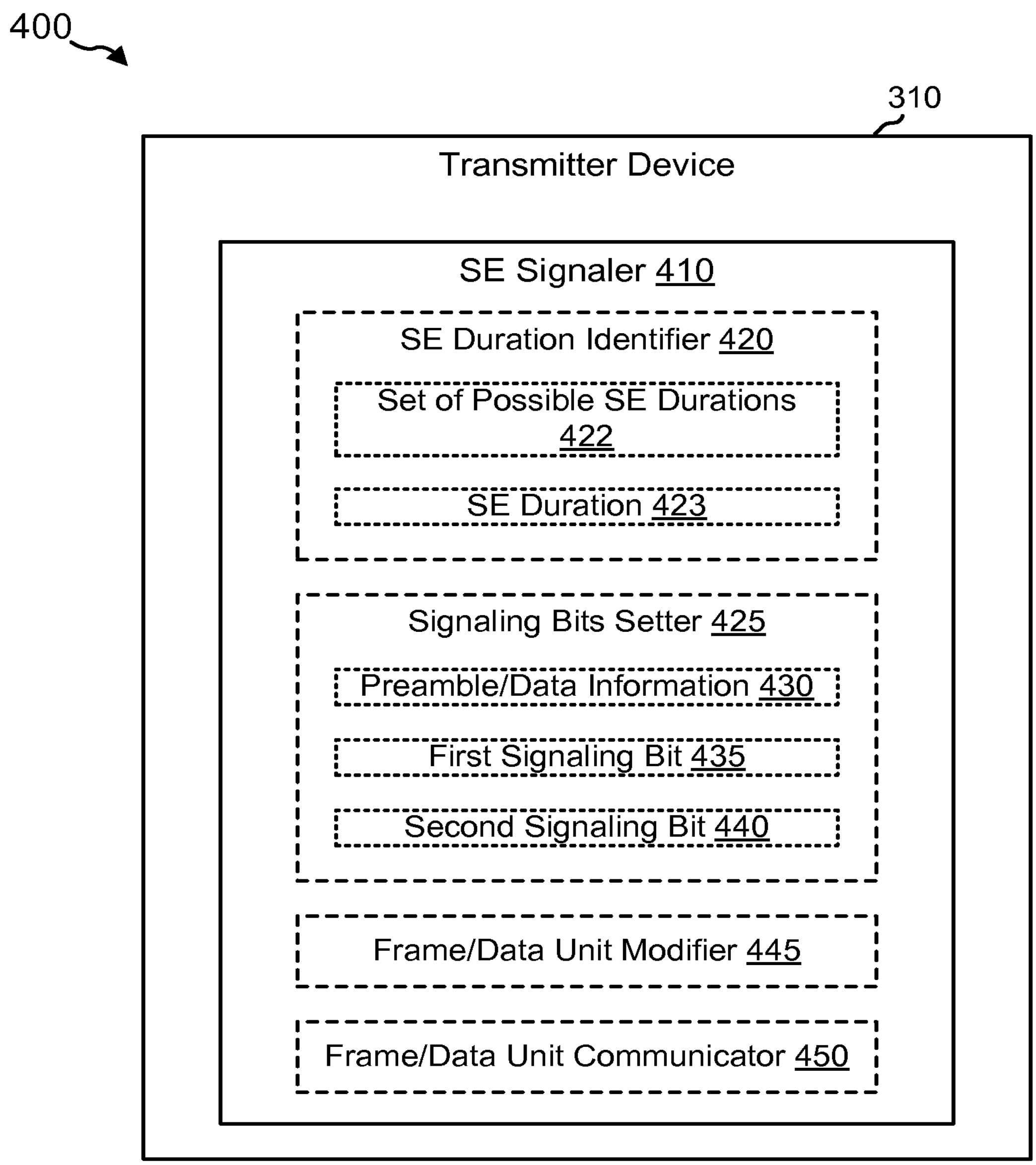
400
310
Transmitter Device
SE Signaler 410
SE Duration Identifier 420
Set of Possible SE Durations 422
SE Duration 423
Signaling Bits Setter 425
Preamble/Data Information 430
First Signaling Bit 435
Second Signaling Bit 440
Frame/Data Unit Modifier 445
Frame/Data Unit Communicator 450

FIG. 4

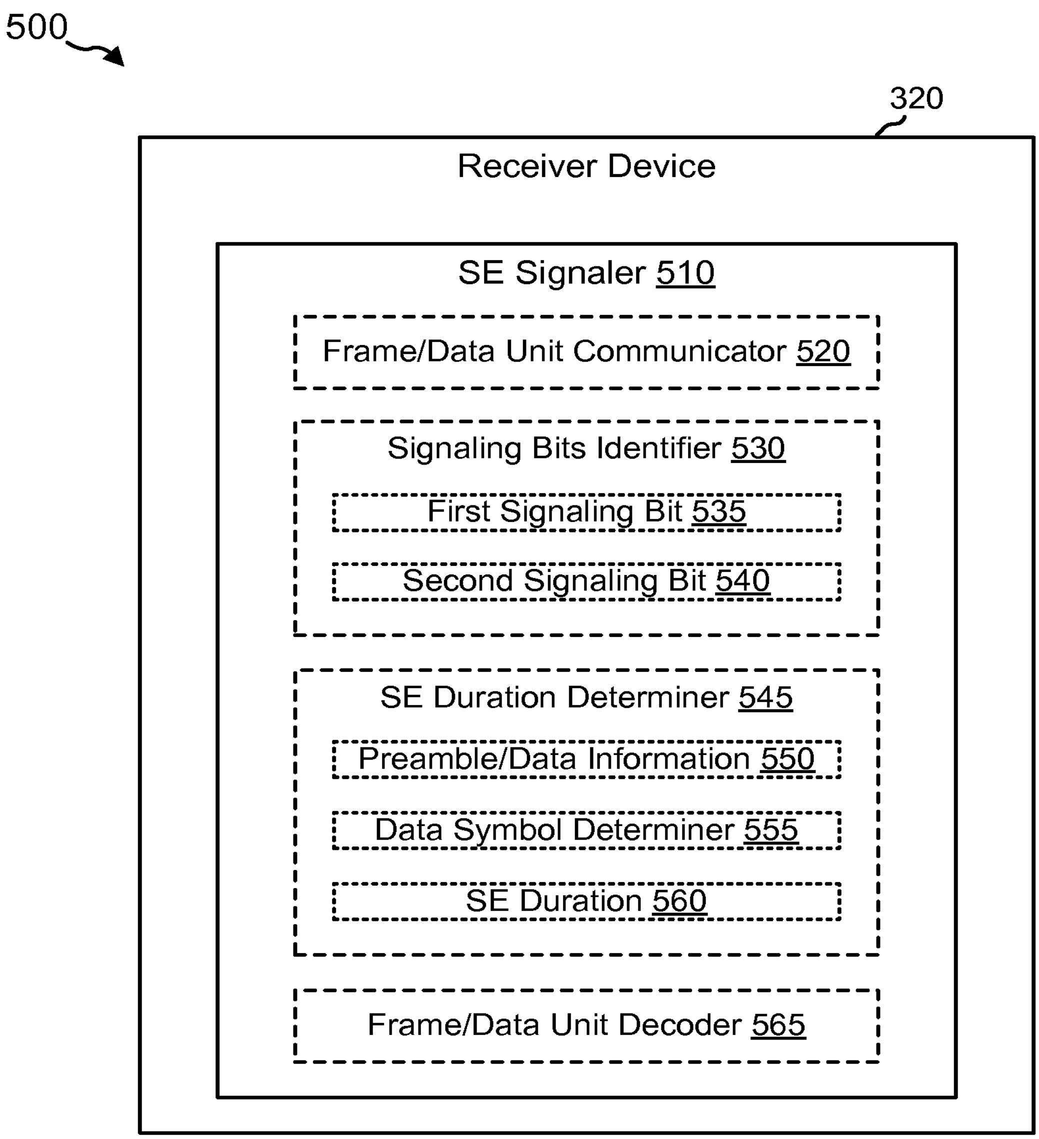
500
320
Receiver Device
SE Signaler 510
Frame/Data Unit Communicator 520
Signaling Bits Identifier 530
First Signaling Bit 535
Second Signaling Bit 540
SE Duration Determiner 545
Preamble/Data Information 550
Data Symbol Determiner 555
SE Duration 560
Frame/Data Unit Decoder 565

FIG. 5

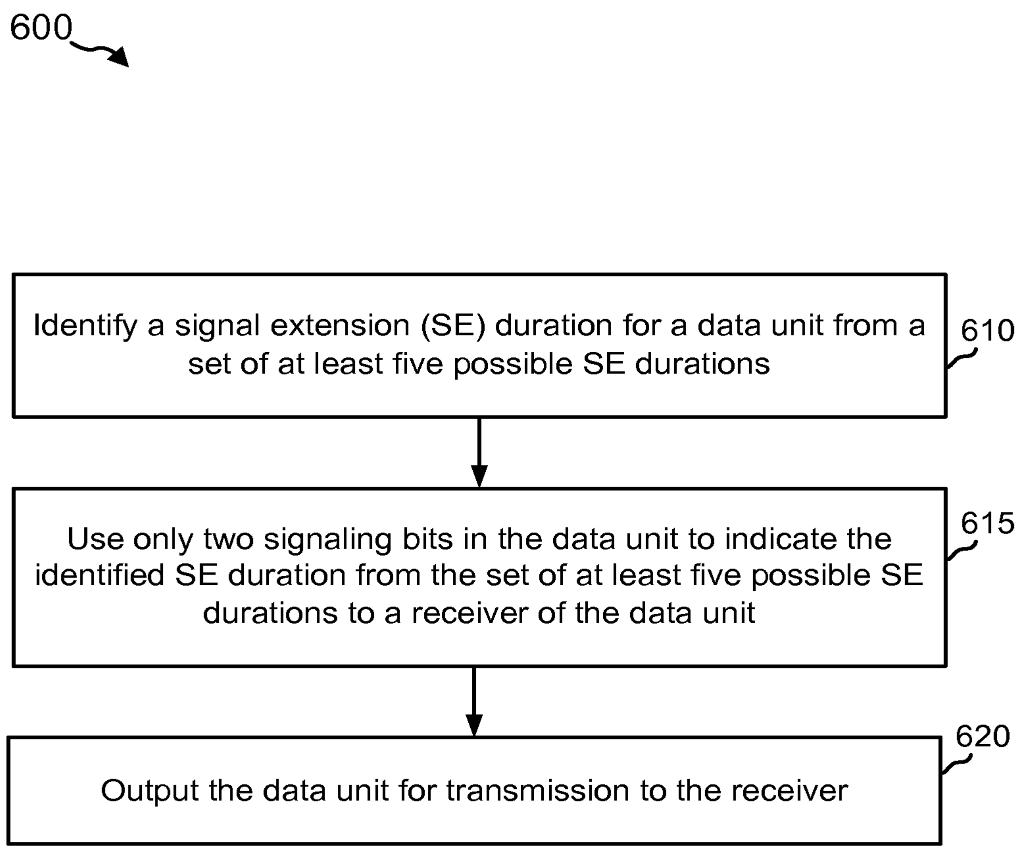
600
Identify a signal extension (SE) duration for a data unit from a set of at least five possible SE durations
610
Use only two signaling bits in the data unit to indicate the identified SE duration from the set of at least five possible SE durations to a receiver of the data unit
615
Output the data unit for transmission to the receiver
620

FIG. 6

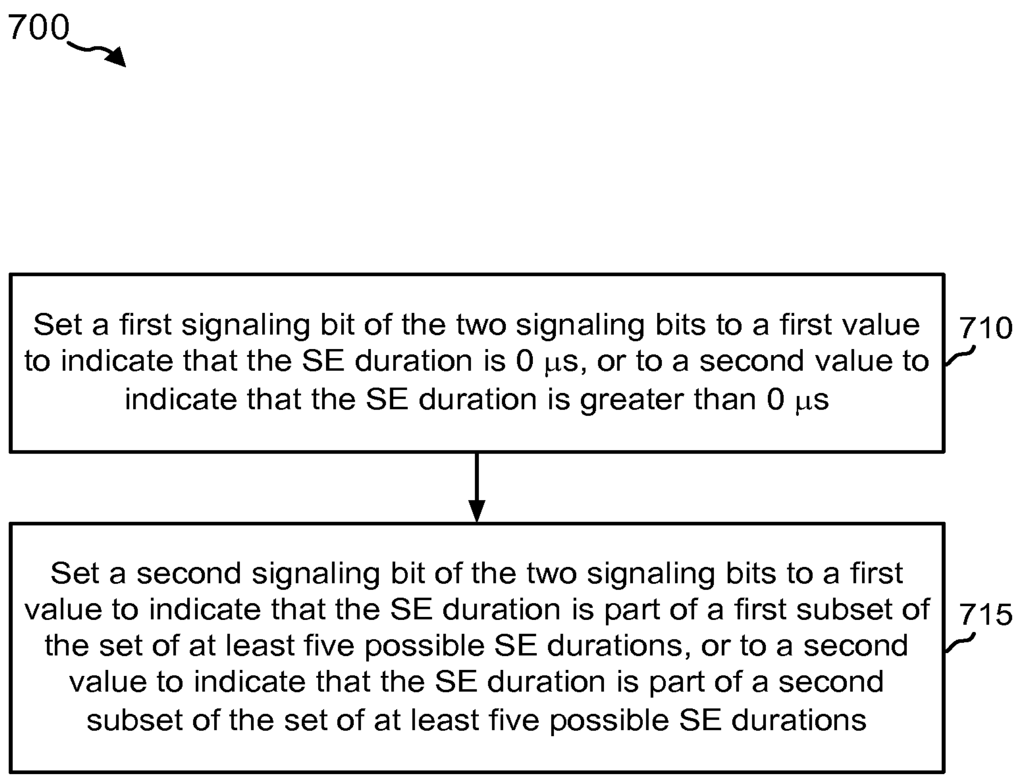
700
Set a first signaling bit of the two signaling bits to a first value to indicate that the SE duration is 0 μs, or to a second value to indicate that the SE duration is greater than 0 μs
710
Set a second signaling bit of the two signaling bits to a first value to indicate that the SE duration is part of a first subset of the set of at least five possible SE durations, or to a second value to indicate that the SE duration is part of a second subset of the set of at least five possible SE durations
715

FIG. 7

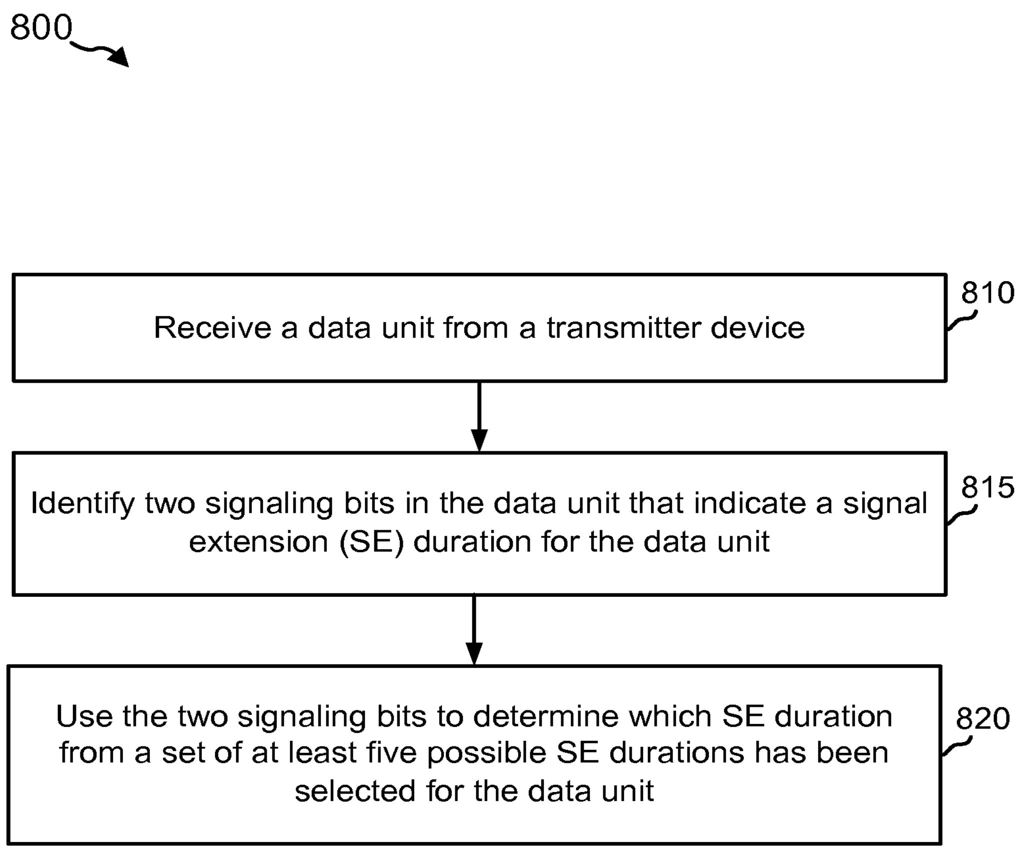
800
Receive a data unit from a transmitter device
810
Identify two signaling bits in the data unit that indicate a signal extension (SE) duration for the data unit
815
Use the two signaling bits to determine which SE duration from a set of at least five possible SE durations has been selected for the data unit
820

FIG. 8

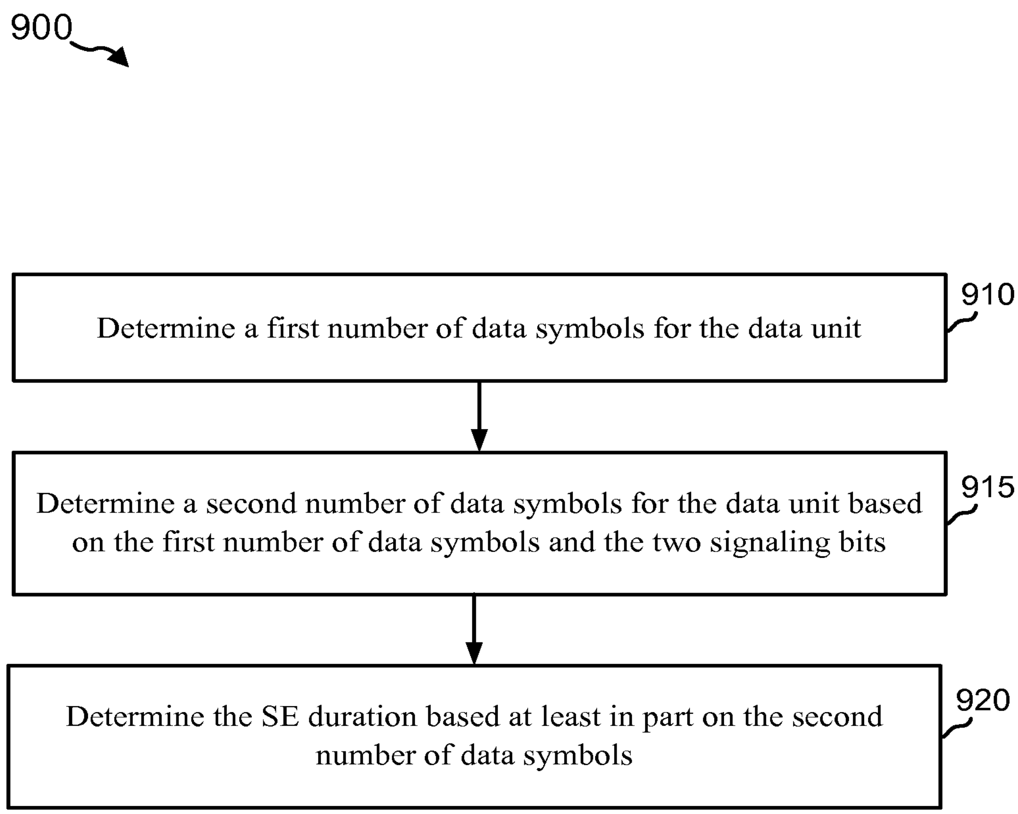
900
Determine a first number of data symbols for the data unit
910
Determine a second number of data symbols for the data unit based on the first number of data symbols and the two signaling bits
915
Determine the SE duration based at least in part on the second number of data symbols
920

FIG. 9

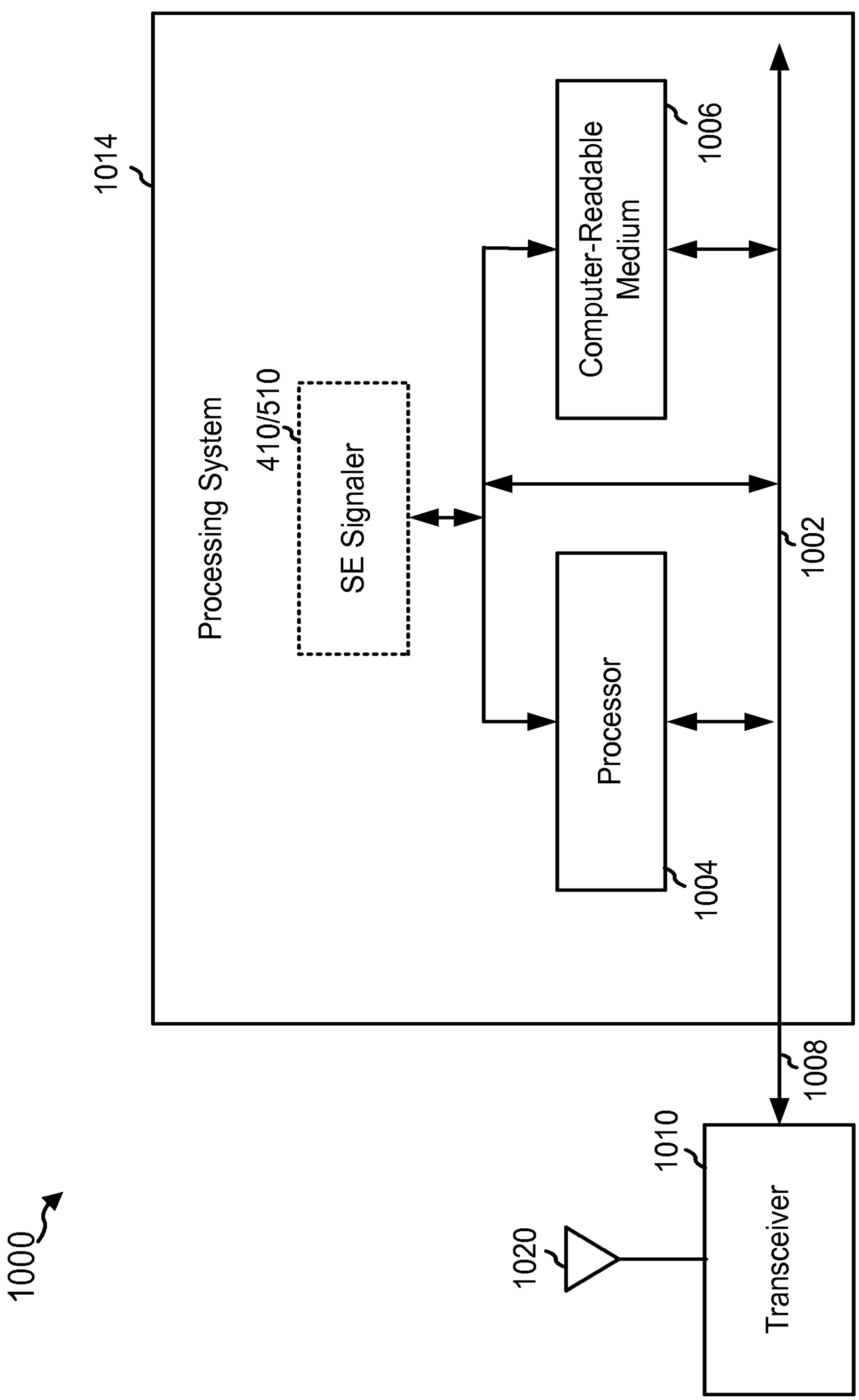
1000
1014
Processing System
410/510
SE Signaler
Computer-Readable Medium
1006
Processor
1004
1002
1008
1010
Transceiver
1020

FIG. 10

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
62/165,848	05/22/2015		260	030284.10181/153742P1		

CONFIRMATION NO. 7854

FILING RECEIPT

OC000000075522395

15142
Arent Fox, LLP and Qualcomm, Incorporated
1717 K Street, NW
Washington, DC 20006-5344

Date Mailed: 06/04/2015

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QUALCOMM Incorporated, San Diego, CA;

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Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

Title

TECHNIQUES FOR SIGNAL EXTENSION SIGNALING

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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