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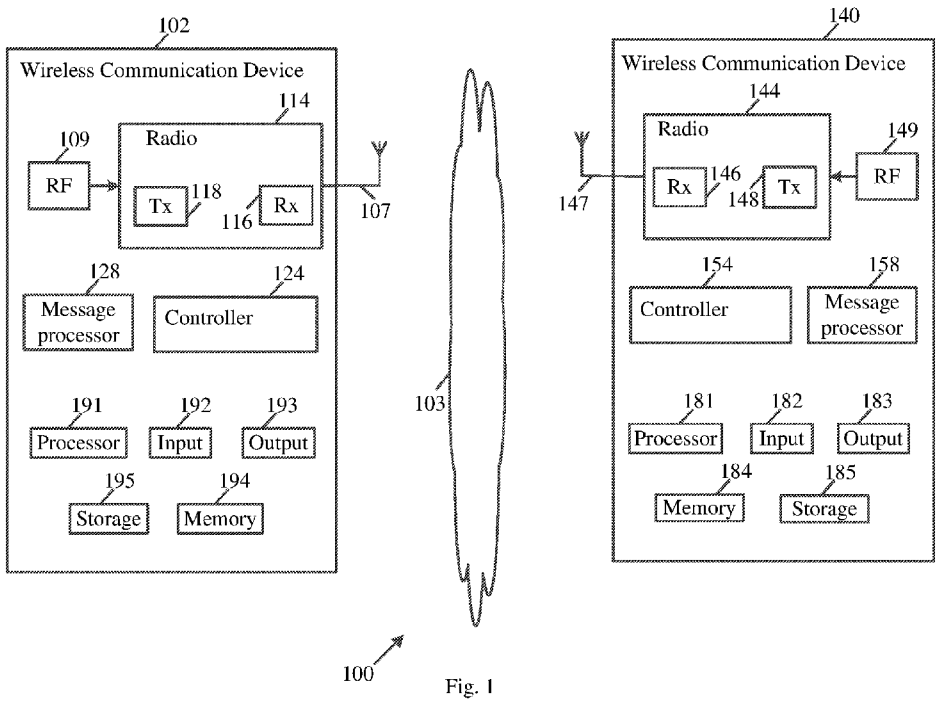

Fig. 1

(57) Abstract: In one example, a trigger frame may be communicated from an Access Point (AP) Station (STA) to a non-AP STA to indicate an allocation of an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP STA. In another example, a STA may communicate a Broadcast (BC) Target Wake Time (TWT) element including a bitmap, the bitmap including a plurality of bits corresponding to a respective plurality of TWT periods, wherein a bit in the bitmap corresponding to a TWT period is set to 1 to indicate that there is at least one STA associated with the TWT period.

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APPARATUS, SYSTEM, AND METHOD OF ADVANCED WIRELESS COMMUNICATION

CROSS REFERENCE

[001] This application claims the benefit of and priority from US Provisional Patent Application No. 63/073,261 entitled "Enhanced Single User Triggered Operation", filed September 1, 2020, and from US Provisional Patent Application No. 63/079,064 entitled "Restricted Target Wake Time (TWT) with Bitmap", filed September 16, 2020, the entire disclosures of both of which are incorporated herein by reference.

TECHNICAL FIELD

[002] Embodiments described herein generally relate to advanced wireless communication.

BACKGROUND

[003] Some wireless communication networks may provide high-throughput data for users of wireless communication devices. For example, some wireless communication networks may utilize wide bandwidths for wireless transmissions.

[004] There is a need for technical solutions to provide increased and/or efficient access to the wireless communication medium.

BRIEF DESCRIPTION OF THE DRAWINGS

[005] For simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity of presentation. Furthermore, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. The figures are listed below.

[006] Fig. 1 is a schematic block diagram illustration of a system, in accordance with some demonstrative embodiments.

[007] Fig. 2 is a schematic illustration of an Extremely High Throughput (EHT) Physical layer (PHY) Protocol Data Unit (PPDU) format, which may be implemented in accordance with some demonstrative embodiments.

[008] Fig. 3 is a schematic illustration of communications between an Access Point (AP) Multi-Link Device (MLD) and a non-AP MLD, to illustrate technical issues, which may be addressed in accordance with some demonstrative embodiments.

[009] Fig. 4 is a schematic illustration of a time allocation within a Transmit Opportunity (TxOP), in accordance with some demonstrative embodiments.

[0010] Fig. 5 is a schematic illustration of a time allocation within a TxOP, in accordance with some demonstrative embodiments.

[0011] Fig. 6 is a schematic illustration of a time allocation within a TxOP, in accordance with some demonstrative embodiments.

[0012] Fig. 7 is a schematic illustration of a time allocation within a TxOP, in accordance with some demonstrative embodiments.

[0013] Fig. 8 is a schematic illustration of fields in a common information (info) field, in accordance with some demonstrative embodiments.

[0014] Fig. 9 is a schematic illustration of fields in a user info field, in accordance with some demonstrative embodiments.

[0015] Fig. 10 is a schematic illustration of a Target Wake Time (TWT) allocation, in accordance with some demonstrative embodiments.

[0016] Fig. 11 is a schematic flow-chart illustration of a method of time allocation within a TxOP, in accordance with some demonstrative embodiments.

[0017] Fig. 12 is a schematic flow-chart illustration of a method of time allocation within a TxOP, in accordance with some demonstrative embodiments.

[0018] Fig. 13 is a schematic flow-chart illustration of a method of communication based on a TWT allocation, in accordance with some demonstrative embodiments.

[0019] Fig. 14 is a schematic flow-chart illustration of a method of communication based on a TWT allocation, in accordance with some demonstrative embodiments.

[0020] Fig. 15 is a schematic illustration of a product of manufacture, in accordance with some demonstrative embodiments.

DETAILED DESCRIPTION

[0021] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of some embodiments. However, it will be understood by persons of ordinary skill in the art that some embodiments may be practiced without these specific details. In other instances, well-known methods, procedures, components, units and/or circuits have not been described in detail so as not to obscure the discussion.

[0022] Discussions herein utilizing terms such as, for example, "processing", "computing", "calculating", "determining", "establishing", "analyzing", "checking", or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device, that manipulate and/or transform data represented as physical (e.g., electronic) quantities within the computer's registers and/or memories into other data similarly represented as physical quantities within the computer's registers and/or memories or other information storage medium that may store instructions to perform operations and/or processes.

[0023] The terms "plurality" and "a plurality", as used herein, include, for example, "multiple" or "two or more". For example, "a plurality of items" includes two or more items.

[0024] References to "one embodiment", "an embodiment", "demonstrative embodiment", "various embodiments" etc., indicate that the embodiment(s) so described may include a particular feature, structure, or characteristic, but not every embodiment necessarily includes the particular feature, structure, or characteristic. Further, repeated use of the phrase "in one embodiment" does not necessarily refer to the same embodiment, although it may.

[0025] As used herein, unless otherwise specified the use of the ordinal adjectives "first", "second", "third" etc., to describe a common object, merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking, or in any other manner.

[0026] Some aspects may be used in conjunction with various devices and systems, for example, a User Equipment (UE), a Mobile Device (MD), a wireless station (STA), a

Personal Computer (PC), a desktop computer, a mobile computer, a laptop computer, a notebook computer, a tablet computer, a server computer, a handheld computer, a handheld device, a wearable device, a sensor device, an Internet of Things (IoT) device, a Personal Digital Assistant (PDA) device, a handheld PDA device, an on-board device, an off-board device, a hybrid device, a vehicular device, a non-vehicular device, a mobile or portable device, a consumer device, a non-mobile or non-portable device, a wireless communication station, a wireless communication device, a wireless Access Point (AP), a wired or wireless router, a wired or wireless modem, a video device, an audio device, an audio-video (A/V) device, a wired or wireless network, a wireless area network, a Wireless Video Area Network (WVAN), a Local Area Network (LAN), a Wireless LAN (WLAN), a Personal Area Network (PAN), a Wireless PAN (WPAN), and the like.

[0027] Some aspects may be used in conjunction with devices and/or networks operating in accordance with existing IEEE 802.11 standards (including IEEE 802.11-2020 (*IEEE 802.11-2020, IEEE Standard for Information technology--Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements; Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, February 2021*); and/or IEEE 802.11be (IEEE *P802.11be/D1.0 Draft Standard for Information technology— Telecommunications and information exchange between systems Local and metropolitan area networks— Specific requirements; Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; Amendment 8: Enhancements for extremely high throughput (EHT), May 2021*)) and/or future versions and/or derivatives thereof, devices and/or networks operating in accordance with existing cellular specifications and/or protocols, e.g., 3rd Generation Partnership Project (3GPP), 3GPP Long Term Evolution (LTE) and/or future versions and/or derivatives thereof, units and/or devices which are part of the above networks, and the like.

[0028] Some aspects may be used in conjunction with one way and/or two-way radio communication systems, cellular radio-telephone communication systems, a mobile phone, a cellular telephone, a wireless telephone, a Personal Communication Systems (PCS) device, a PDA device which incorporates a wireless communication device, a

mobile or portable Global Positioning System (GPS) device, a device which incorporates a GPS receiver or transceiver or chip, a device which incorporates an RFID element or chip, a Multiple Input Multiple Output (MIMO) transceiver or device, a Single Input Multiple Output (SIMO) transceiver or device, a Multiple Input Single Output (MISO) transceiver or device, a device having one or more internal antennas and/or external antennas, Digital Video Broadcast (DVB) devices or systems, multi-standard radio devices or systems, a wired or wireless handheld device, e.g., a Smartphone, a Wireless Application Protocol (WAP) device, or the like.

[0029] Some aspects may be used in conjunction with one or more types of wireless communication signals and/or systems, for example, Radio Frequency (RF), Infra-Red (IR), Frequency-Division Multiplexing (FDM), Orthogonal Frequency-Division Multiplexing (OFDM), Orthogonal Frequency-Division Multiple Access (OFDMA), FDM Time-Division Multiplexing (TDM), Time-Division Multiple Access (TDMA), Multi-User MIMO (MU-MIMO), Spatial Division Multiple Access (SDMA), Extended TDMA (E-TDMA), General Packet Radio Service (GPRS), extended GPRS, Code-Division Multiple Access (CDMA), Wideband CDMA (WCDMA), CDMA 2000, single-carrier CDMA, multi-carrier CDMA, Multi-Carrier Modulation (MDM), Discrete Multi-Tone (DMT), Bluetooth®, Global Positioning System (GPS), Wi-Fi, Wi-Max, ZigBee™, Ultra-Wideband (UWB), Global System for Mobile communication (GSM), 4G, Fifth Generation (5G), or Sixth Generation (6G) mobile networks, 3GPP, Long Term Evolution (LTE), LTE advanced, Enhanced Data rates for GSM Evolution (EDGE), or the like. Other aspects may be used in various other devices, systems and/or networks.

[0030] The term "wireless device", as used herein, includes, for example, a device capable of wireless communication, a communication device capable of wireless communication, a communication station capable of wireless communication, a portable or non-portable device capable of wireless communication, or the like. In some demonstrative aspects, a wireless device may be or may include a peripheral that may be integrated with a computer, or a peripheral that may be attached to a computer. In some demonstrative aspects, the term "wireless device" may optionally include a wireless service.

[0031] The term "communicating" as used herein with respect to a communication signal includes transmitting the communication signal and/or receiving the communication signal. For example, a communication unit, which is capable of communicating a communication signal, may include a transmitter to transmit the communication signal to at least one other communication unit, and/or a communication receiver to receive the communication signal from at least one other communication unit. The verb communicating may be used to refer to the action of transmitting or the action of receiving. In one example, the phrase "communicating a signal" may refer to the action of transmitting the signal by a first device, and may not necessarily include the action of receiving the signal by a second device. In another example, the phrase "communicating a signal" may refer to the action of receiving the signal by a first device, and may not necessarily include the action of transmitting the signal by a second device. The communication signal may be transmitted and/or received, for example, in the form of Radio Frequency (RF) communication signals, and/or any other type of signal.

[0032] As used herein, the term "circuitry" may refer to, be part of, or include, an Application Specific Integrated Circuit (ASIC), an integrated circuit, an electronic circuit, a processor (shared, dedicated, or group) and/or memory (shared, dedicated, or group), that execute one or more software or firmware programs, a combinational logic circuit, and/or other suitable hardware components that provide the described functionality. In some aspects, the circuitry may be implemented in, or functions associated with the circuitry may be implemented by, one or more software or firmware modules. In some aspects, circuitry may include logic, at least partially operable in hardware.

[0033] The term "logic" may refer, for example, to computing logic embedded in circuitry of a computing apparatus and/or computing logic stored in a memory of a computing apparatus. For example, the logic may be accessible by a processor of the computing apparatus to execute the computing logic to perform computing functions and/or operations. In one example, logic may be embedded in various types of memory and/or firmware, e.g., silicon blocks of various chips and/or processors. Logic may be included in, and/or implemented as part of, various circuitry, e.g. radio circuitry, receiver circuitry, control circuitry, transmitter circuitry, transceiver circuitry,

processor circuitry, and/or the like. In one example, logic may be embedded in volatile memory and/or non-volatile memory, including random access memory, read only memory, programmable memory, magnetic memory, flash memory, persistent memory, and the like. Logic may be executed by one or more processors using memory, e.g., registers, stuck, buffers, and/or the like, coupled to the one or more processors, e.g., as necessary to execute the logic.

[0034] Some demonstrative aspects may be used in conjunction with a WLAN, e.g., a WiFi network. Other aspects may be used in conjunction with any other suitable wireless communication network, for example, a wireless area network, a "piconet", a WPAN, a WVAN and the like.

[0035] Some demonstrative aspects may be used in conjunction with a wireless communication network communicating over a frequency band between 1GHz and 7.250Ghz, for example, a 2.4 Gigahertz (GHz) frequency band, a 5GHz frequency band, and/or a 6GHz frequency band. However, other aspects may be implemented utilizing any other suitable wireless communication frequency bands, for example, an Extremely High Frequency (EHF) band (the millimeter wave (mmWave) frequency band), e.g., a frequency band within the frequency band of between 20Ghz and 300GHz, a frequency band above 45GHz, a 5G frequency band, a frequency band below 20GHz, e.g., a Sub 1 GHz (S1G) band, a WLAN frequency band, a WPAN frequency band, a frequency band according to the WGA specification, and the like.

[0036] The term "antenna", as used herein, may include any suitable configuration, structure and/or arrangement of one or more antenna elements, components, units, assemblies and/or arrays. In some aspects, the antenna may implement transmit and receive functionalities using separate transmit and receive antenna elements. In some aspects, the antenna may implement transmit and receive functionalities using common and/or integrated transmit/receive elements. The antenna may include, for example, a phased array antenna, a single element antenna, a set of switched beam antennas, and/or the like.

[0037] Some demonstrative embodiments may be implemented by an Extremely High Throughput (EHT) STA, which may include for example, a STA having a radio transmitter, which is capable of operating on a channel that is in frequency bands between 1GHz and 7.250Ghz. The EHT STA may perform other additional or

alternative functionality. Other embodiments may be implemented by any other apparatus, device and/or station.

[0038] Reference is made to Fig. 1, which schematically illustrates a system 100, in accordance with some demonstrative embodiments.

[0039] As shown in Fig. 1, in some demonstrative embodiments, system 100 may include one or more wireless communication devices. For example, system 100 may include a wireless communication device 102, a wireless communication device 140, and/or one more other devices.

[0040] In some demonstrative embodiments, devices 102 and/or 140 may include a mobile device or a non-mobile, e.g., a static, device.

[0041] For example, devices 102 and/or 140 may include, for example, a UE, an MD, a STA, an AP, a Smartphone, a PC, a desktop computer, a mobile computer, a laptop computer, an Ultrabook™ computer, a notebook computer, a tablet computer, a server computer, a handheld computer, an Internet of Things (IoT) device, a sensor device, a handheld device, a wearable device, a PDA device, a handheld PDA device, an on-board device, an off-board device, a hybrid device (e.g., combining cellular phone functionalities with PDA device functionalities), a consumer device, a vehicular device, a non-vehicular device, a mobile or portable device, a non-mobile or non-portable device, a mobile phone, a cellular telephone, a PCS device, a PDA device which incorporates a wireless communication device, a mobile or portable GPS device, a DVB device, a relatively small computing device, a non-desktop computer, a "Carry Small Live Large" (CSLL) device, an Ultra Mobile Device (UMD), an Ultra Mobile PC (UMPC), a Mobile Internet Device (MID), an "Origami" device or computing device, a device that supports Dynamically Composable Computing (DCC), a context-aware device, a video device, an audio device, an A/V device, a Set-Top-Box (STB), a video source, an audio source, a video sink, an audio sink, a stereo tuner, a broadcast radio receiver, a digital audio player, a speaker, an audio receiver, an audio amplifier, a gaming device, a data source, a data sink, a media player, a television, a music player, a smart device such as, for example, lamps, climate control, car components, household components, appliances, and the like.

[0042] In some demonstrative embodiments, device 102 may include, for example, one or more of a processor 191, an input unit 192, an output unit 193, a memory unit 194, and/or a storage unit 195; and/or device 140 may include, for example, one or more of a processor 181, an input unit 182, an output unit 183, a memory unit 184, and/or a storage unit 185. Devices 102 and/or 140 may optionally include other suitable hardware components and/or software components. In some demonstrative embodiments, some or all of the components of one or more of devices 102 and/or 140 may be enclosed in a common housing or packaging, and may be interconnected or operably associated using one or more wired or wireless links. In other embodiments, components of one or more of devices 102 and/or 140 may be distributed among multiple or separate devices.

[0043] In some demonstrative embodiments, processor 191 and/or processor 181 may include, for example, a Central Processing Unit (CPU), a Digital Signal Processor (DSP), one or more processor cores, a single-core processor, a dual-core processor, a multiple-core processor, a microprocessor, a host processor, a controller, a plurality of processors or controllers, a chip, a microchip, one or more circuits, circuitry, a logic unit, an Integrated Circuit (IC), an Application-Specific IC (ASIC), or any other suitable multi-purpose or specific processor or controller. Processor 191 may execute instructions, for example, of an Operating System (OS) of device 102 and/or of one or more suitable applications. Processor 181 may execute instructions, for example, of an Operating System (OS) of device 140 and/or of one or more suitable applications.

[0044] In some demonstrative embodiments, input unit 192 and/or input unit 182 may include, for example, a keyboard, a keypad, a mouse, a touch-screen, a touch-pad, a track-ball, a stylus, a microphone, or other suitable pointing device or input device. Output unit 193 and/or output unit 183 may include, for example, a display, a screen, a touch-screen, one or more audio speakers or earphones, and/or other suitable output devices.

[0045] In some demonstrative embodiments, memory unit 194 and/or memory unit 184 includes, for example, a Random Access Memory (RAM), a Read Only Memory (ROM), a Dynamic RAM (DRAM), a Synchronous DRAM (SD-RAM), a flash memory, a volatile memory, a non-volatile memory, a cache memory, a buffer, a short term memory unit, a long term memory unit, or other suitable memory units. Storage

unit 195 and/or storage unit 185 may include, for example, a hard disk drive, a disk drive, a solid-state drive (SSD), and/or other suitable removable or non-removable storage units. Memory unit 194 and/or storage unit 195, for example, may store data processed by device 102. Memory unit 184 and/or storage unit 185, for example, may store data processed by device 140.

[0046] In some demonstrative embodiments, wireless communication devices 102 and/or 140 may be capable of communicating content, data, information and/or signals via a wireless medium (WM) 103. In some demonstrative embodiments, wireless medium 103 may include, for example, a radio channel, a cellular channel, an RF channel, a WiFi channel, a 5G channel, an IR channel, a Bluetooth (BT) channel, a Global Navigation Satellite System (GNSS) Channel, and the like.

[0047] In some demonstrative embodiments, device 102 and/or device 140 may include one or more radios including circuitry and/or logic to perform wireless communication between devices 102, 140 and/or one or more other wireless communication devices. For example, device 102 may include at least one radio 114, and/or device 140 may include at least one radio 144.

[0048] In some demonstrative embodiments, radio 114 and/or radio 144 may include one or more wireless receivers (Rx) including circuitry and/or logic to receive wireless communication signals, RF signals, frames, blocks, transmission streams, packets, messages, data items, and/or data. For example, radio 114 may include at least one receiver 116, and/or radio 144 may include at least one receiver 146.

[0049] In some demonstrative embodiments, radio 114 and/or radio 144 may include one or more wireless transmitters (Tx) including circuitry and/or logic to transmit wireless communication signals, RF signals, frames, blocks, transmission streams, packets, messages, data items, and/or data. For example, radio 114 may include at least one transmitter 118, and/or radio 144 may include at least one transmitter 148.

[0050] In some demonstrative embodiments, radio 114 and/or radio 144, transmitters 118 and/or 148, and/or receivers 116 and/or 146 may include circuitry; logic; Radio Frequency (RF) elements, circuitry and/or logic; baseband elements, circuitry and/or logic; modulation elements, circuitry and/or logic; demodulation elements, circuitry and/or logic; amplifiers; analog to digital and/or digital to analog converters; filters;

and/or the like. For example, radio 114 and/or radio 144 may include or may be implemented as part of a wireless Network Interface Card (NIC), and the like.

[0051] In some demonstrative embodiments, radios 114 and/or 144 may be configured to communicate over a directional band, for example, a frequency band in frequency bands between 1 GHz and 7.250 GHz, for example, a 2.4GHz band, a 5GHz band, a 6GHz band, and/or any other frequency band, for example, frequency band above 45 GHz, an S1G band, and/or any other band.

[0052] In some demonstrative embodiments, radios 114 and/or 144 may include, or may be associated with one or more, e.g., a plurality of, antennas.

[0053] In some demonstrative embodiments, device 102 may include one or more, e.g., a single antenna or a plurality of, antennas 107, and/or device 140 may include on or more, e.g., a plurality of, antennas 147.

[0054] Antennas 107 and/or 147 may include any type of antennas suitable for transmitting and/or receiving wireless communication signals, blocks, frames, transmission streams, packets, messages and/or data. For example, antennas 107 and/or 147 may include any suitable configuration, structure and/or arrangement of one or more antenna elements, components, units, assemblies and/or arrays. Antennas 107 and/or 147 may include, for example, antennas suitable for directional communication, e.g., using beamforming techniques. For example, antennas 107 and/or 147 may include a single antenna, a plurality of antennas, a phased array antenna, a multiple element antenna, a set of switched beam antennas, and/or the like. In some embodiments, antennas 107 and/or 147 may implement transmit and receive functionalities using separate transmit and receive antenna elements. In some embodiments, antennas 107 and/or 147 may implement transmit and receive functionalities using common and/or integrated transmit/receive elements.

[0055] In some demonstrative embodiments, antennas 107 and/or antennas 147 may be connected to, and/or associated with, one or more Radio Frequency (RF) chains.

[0056] In some demonstrative embodiments, device 102 may include one or more, e.g., a plurality of, RF chains 109 connected to, and/or associated with, antennas 107.

[0057] In some demonstrative embodiments, one or more of RF chains 109 may be included as part of, and/or implemented as part of one or more elements of radio 114, e.g., as part of transmitter 118 and/or receiver 116.

[0058] In some demonstrative embodiments, device 140 may include one or more, e.g., a plurality of, RF chains 149 connected to, and/or associated with, antennas 147.

[0059] In some demonstrative embodiments, one or more of RF chains 149 may be included as part of, and/or implemented as part of one or more elements of radio 144, e.g., as part of transmitter 148 and/or receiver 146.

[0060] In some demonstrative embodiments, device 102 may include a controller 124, and/or device 140 may include a controller 154. Controller 124 may be configured to perform and/or to trigger, cause, instruct and/or control device 102 to perform, one or more communications, to generate and/or communicate one or more messages and/or transmissions, and/or to perform one or more functionalities, operations and/or procedures between devices 102, 140 and/or one or more other devices; and/or controller 154 may be configured to perform, and/or to trigger, cause, instruct and/or control device 140 to perform, one or more communications, to generate and/or communicate one or more messages and/or transmissions, and/or to perform one or more functionalities, operations and/or procedures between devices 102, 140 and/or one or more other devices, e.g., as described below.

[0061] In some demonstrative embodiments, controllers 124 and/or 154 may include, or may be implemented, partially or entirely, by circuitry and/or logic, e.g., one or more processors including circuitry and/or logic, memory circuitry and/or logic, Media-Access Control (MAC) circuitry and/or logic, Physical Layer (PHY) circuitry and/or logic, baseband (BB) circuitry and/or logic, a BB processor, a BB memory, Application Processor (AP) circuitry and/or logic, an AP processor, an AP memory, and/or any other circuitry and/or logic, configured to perform the functionality of controllers 124 and/or 154, respectively. Additionally or alternatively, one or more functionalities of controllers 124 and/or 154 may be implemented by logic, which may be executed by a machine and/or one or more processors, e.g., as described below.

[0062] In one example, controller 124 may include circuitry and/or logic, for example, one or more processors including circuitry and/or logic, to cause, trigger and/or control

a wireless device, e.g., device 102, and/or a wireless station, e.g., a wireless STA implemented by device 102, to perform one or more operations, communications and/or functionalities, e.g., as described herein. In one example, controller 124 may include at least one memory, e.g., coupled to the one or more processors, which may be configured, for example, to store, e.g., at least temporarily, at least some of the information processed by the one or more processors and/or circuitry, and/or which may be configured to store logic to be utilized by the processors and/or circuitry.

[0063] In one example, controller 154 may include circuitry and/or logic, for example, one or more processors including circuitry and/or logic, to cause, trigger and/or control a wireless device, e.g., device 140, and/or a wireless station, e.g., a wireless STA implemented by device 140, to perform one or more operations, communications and/or functionalities, e.g., as described herein. In one example, controller 154 may include at least one memory, e.g., coupled to the one or more processors, which may be configured, for example, to store, e.g., at least temporarily, at least some of the information processed by the one or more processors and/or circuitry, and/or which may be configured to store logic to be utilized by the processors and/or circuitry.

[0064] In some demonstrative embodiments, at least part of the functionality of controller 124 may be implemented as part of one or more elements of radio 114, and/or at least part of the functionality of controller 154 may be implemented as part of one or more elements of radio 144.

[0065] In other embodiments, the functionality of controller 124 may be implemented as part of any other element of device 102, and/or the functionality of controller 154 may be implemented as part of any other element of device 140.

[0066] In some demonstrative embodiments, device 102 may include a message processor 128 configured to generate, process and/or access one or messages communicated by device 102.

[0067] In one example, message processor 128 may be configured to generate one or more messages to be transmitted by device 102, and/or message processor 128 may be configured to access and/or to process one or more messages received by device 102, e.g., as described below.

[0068] In one example, message processor 128 may include at least one first component configured to generate a message, for example, in the form of a frame, field, information element and/or protocol data unit, for example, a MAC Protocol Data Unit (MPDU); at least one second component configured to convert the message into a PHY Protocol Data Unit (PPDU), for example, by processing the message generated by the at least one first component, e.g., by encoding the message, modulating the message and/or performing any other additional or alternative processing of the message; and/or at least one third component configured to cause transmission of the message over a wireless communication medium, e.g., over a wireless communication channel in a wireless communication frequency band, for example, by applying to one or more fields of the PPDU one or more transmit waveforms. In other embodiments, message processor 128 may be configured to perform any other additional or alternative functionality and/or may include any other additional or alternative components to generate and/or process a message to be transmitted.

[0069] In some demonstrative embodiments, device 140 may include a message processor 158 configured to generate, process and/or access one or messages communicated by device 140.

[0070] In one example, message processor 158 may be configured to generate one or more messages to be transmitted by device 140, and/or message processor 158 may be configured to access and/or to process one or more messages received by device 140, e.g., as described below.

[0071] In one example, message processor 158 may include at least one first component configured to generate a message, for example, in the form of a frame, field, information element and/or protocol data unit, for example, a MAC Protocol Data Unit (MPDU); at least one second component configured to convert the message into a PHY Protocol Data Unit (PPDU), for example, by processing the message generated by the at least one first component, e.g., by encoding the message, modulating the message and/or performing any other additional or alternative processing of the message; and/or at least one third component configured to cause transmission of the message over a wireless communication medium, e.g., over a wireless communication channel in a wireless communication frequency band, for example, by applying to one or more fields of the PPDU one or more transmit waveforms. In other embodiments, message

processor 158 may be configured to perform any other additional or alternative functionality and/or may include any other additional or alternative components to generate and/or process a message to be transmitted.

[0072] In some demonstrative embodiments, message processors 128 and/or 158 may include, or may be implemented, partially or entirely, by circuitry and/or logic, e.g., one or more processors including circuitry and/or logic, memory circuitry and/or logic, Media-Access Control (MAC) circuitry and/or logic, Physical Layer (PHY) circuitry and/or logic, BB circuitry and/or logic, a BB processor, a BB memory, AP circuitry and/or logic, an AP processor, an AP memory, and/or any other circuitry and/or logic, configured to perform the functionality of message processors 128 and/or 158, respectively. Additionally or alternatively, one or more functionalities of message processors 128 and/or 158 may be implemented by logic, which may be executed by a machine and/or one or more processors, e.g., as described below.

[0073] In some demonstrative embodiments, at least part of the functionality of message processor 128 may be implemented as part of radio 114, and/or at least part of the functionality of message processor 158 may be implemented as part of radio 144.

[0074] In some demonstrative embodiments, at least part of the functionality of message processor 128 may be implemented as part of controller 124, and/or at least part of the functionality of message processor 158 may be implemented as part of controller 154.

[0075] In other embodiments, the functionality of message processor 128 may be implemented as part of any other element of device 102, and/or the functionality of message processor 158 may be implemented as part of any other element of device 140.

[0076] In some demonstrative embodiments, at least part of the functionality of controller 124 and/or message processor 128 may be implemented by an integrated circuit, for example, a chip, e.g., a System on Chip (SoC). In one example, the chip or SoC may be configured to perform one or more functionalities of radio 114. For example, the chip or SoC may include one or more elements of controller 124, one or more elements of message processor 128, and/or one or more elements of radio 114. In one example, controller 124, message processor 128, and radio 114 may be implemented as part of the chip or SoC.

[0077] In other embodiments, controller 124, message processor 128 and/or radio 114 may be implemented by one or more additional or alternative elements of device 102.

[0078] In some demonstrative embodiments, at least part of the functionality of controller 154 and/or message processor 158 may be implemented by an integrated circuit, for example, a chip, e.g., a System on Chip (SoC). In one example, the chip or SoC may be configured to perform one or more functionalities of radio 144. For example, the chip or SoC may include one or more elements of controller 154, one or more elements of message processor 158, and/or one or more elements of radio 144. In one example, controller 154, message processor 158, and radio 144 may be implemented as part of the chip or SoC.

[0079] In other embodiments, controller 154, message processor 158 and/or radio 144 may be implemented by one or more additional or alternative elements of device 140.

[0080] In some demonstrative embodiments, device 102 and/or device 140 may include, operate as, perform the role of, and/or perform one or more functionalities of, one or more STAs. For example, device 102 may include at least one STA, and/or device 140 may include at least one STA.

[0081] In some demonstrative embodiments, device 102 and/or device 140 may include, operate as, perform the role of, and/or perform one or more functionalities of, one or more EHT STAs. For example, device 102 may include, operate as, perform the role of, and/or perform one or more functionalities of, at least one EHT STA, and/or device 140 may include, operate as, perform the role of, and/or perform one or more functionalities of, at least one EHT STA.

[0082] In other embodiments, devices 102 and/or 140 may include, operate as, perform the role of, and/or perform one or more functionalities of, any other wireless device and/or station, e.g., a WLAN STA, a WiFi STA, and the like.

[0083] In some demonstrative embodiments, device 102 and/or device 140 may be configured operate as, perform the role of, and/or perform one or more functionalities of, an access point (AP), e.g., an EHT AP.

[0084] In some demonstrative embodiments, device 102 and/or device 140 may be configured to operate as, perform the role of, and/or perform one or more functionalities of, a non-AP STA, e.g., an EHT non-AP STA.

[0085] In other embodiments, device 102 and/or device 140 may operate as, perform the role of, and/or perform one or more functionalities of, any other additional or alternative device and/or station.

[0086] In one example, a station (STA) may include a logical entity that is a singly addressable instance of a medium access control (MAC) and physical layer (PHY) interface to the wireless medium (WM). The STA may perform any other additional or alternative functionality.

[0087] In one example, an AP may include an entity that contains a station (STA), e.g., one STA, and provides access to distribution services, via the wireless medium (WM) for associated STAs. The AP may perform any other additional or alternative functionality.

[0088] In one example, a non-AP STA may include a STA that is not contained within an AP. The non-AP STA may perform any other additional or alternative functionality.

[0089] In some demonstrative embodiments devices 102 and/or 140 may be configured to communicate over an EHT network, and/or any other network. For example, devices 102 and/or 140 may perform Multiple-Input-Multiple-Output (MIMO) communication, for example, for communicating over the EHT networks, e.g., over an EHT frequency band, e.g., in frequency bands between 1 GHz and 7.250 GHz.

[0090] In some demonstrative embodiments, devices 102 and/or 140 may be configured to operate in accordance with one or more Specifications, for example, including one or more *IEEE 802.11 Specifications*, e.g., an *IEEE 802.11-2020 Specification*, an *IEEE 802.11be Specification*, and/or any other specification and/or protocol.

[0091] In some demonstrative embodiments, devices 102 and/or 140 may be configured according to one or more standards, for example, in accordance with an *IEEE 802.11be Standard*, which may be configured, for example, to enhance the efficiency and/or performance of an *IEEE 802.11 Specification*, which may be configured to provide Wi-Fi connectivity.

[0092] Some demonstrative embodiments may enable, for example, to significantly increase the data throughput defined in the *IEEE 802.11-2020 Specification*, for example, up to a throughput of 30 Giga bits per second (Gbps), or to any other

throughput, which may, for example, satisfy growing demand in network capacity for new coming applications.

[0093] Some demonstrative embodiments may be implemented, for example, to support increasing a transmission data rate, for example, by applying MIMO and/or Orthogonal Frequency Division Multiple Access (OFDMA) techniques.

[0094] In some demonstrative embodiments, devices 102 and/or 140 may be configured to communicate MIMO communications and/or OFDMA communication in frequency bands between 1 GHz and 7.250 GHz.

[0095] In some demonstrative embodiments, device 102 and/or device 140 may be configured to support one or more mechanisms and/or features, for example, OFDMA, Single User (SU) MIMO, and/or Multi-User (MU) MIMO, for example, in accordance with an *IEEE 802.11be Standard* and/or any other standard and/or protocol.

[0096] In some demonstrative embodiments, device 102 and/or device 140 may include, operate as, perform a role of, and/or perform the functionality of, one or more EHT STAs. For example, device 102 may include, operate as, perform a role of, and/or perform the functionality of, at least one EHT STA, and/or device 140 may include, operate as, perform a role of, and/or perform the functionality of, at least one EHT STA.

[0097] In some demonstrative embodiments, devices 102 and/or 140 may implement a communication scheme, which may include Physical layer (PHY) and/or Media Access Control (MAC) layer schemes, for example, to support one or more applications, and/or increased throughput, e.g., throughputs up to 30 Gbps, or any other throughput.

[0098] In some demonstrative embodiments, the PHY and/or MAC layer schemes may be configured to support OFDMA techniques, SU MIMO techniques, and/or MU MIMO techniques.

[0099] In some demonstrative embodiments, devices 102 and/or 140 may be configured to implement one or more mechanisms, which may be configured to enable SU and/or MU communication of Downlink (DL) and/or Uplink frames (UL) using a MIMO scheme.

[00100] In some demonstrative embodiments, device 102 and/or device 140 may be configured to implement one or more MU communication mechanisms. For example, devices 102 and/or 140 may be configured to implement one or more MU mechanisms,

which may be configured to enable MU communication of DL frames using a MIMO scheme, for example, between a device, e.g., device 102, and a plurality of devices, e.g., including device 140 and/or one or more other devices.

[00101] In some demonstrative embodiments, devices 102 and/or 140 may be configured to communicate over an EHT network, and/or any other network and/or any other frequency band. For example, devices 102 and/or 140 may be configured to communicate DL transmissions and/or UL transmissions, for example, for communicating over the EHT networks.

[00102] In some demonstrative embodiments, devices 102 and/or 140 may be configured to communicate over a channel bandwidth, e.g., of at least 20 Megahertz (MHz), in frequency bands between 1 GHz and 7.250 GHz.

[00103] In some demonstrative embodiments, devices 102 and/or 140 may be configured to implement one or more mechanisms, which may, for example, support communication over a wide channel bandwidth (BW) ("channel width") (also referred to as a "wide channel" or "wide BW") covering two or more channels, e.g., two or more 20 MHz channels, e.g., as described below.

[00104] In some demonstrative embodiments, wide channel mechanisms may include, for example, a mechanism and/or an operation whereby two or more channels, e.g., 20MHz channels, can be combined, aggregated or bonded, e.g., for a higher bandwidth of packet transmission, for example, to enable achieving higher throughputs, e.g., when compared to transmissions over a single channel. Some demonstrative embodiments are described herein with respect to communication over a channel BW including two or more 20MHz channels, however other embodiments may be implemented with respect to communications over a channel bandwidth, e.g., a "wide" channel, including or formed by any other number of two or more channels, for example, a bonded or aggregated channel including a bonding or an aggregation of two or more channels.

[00105] In some demonstrative embodiments, device 102 and/or device 140 may be configured to communicate one or more transmissions over one or more channel BWs, for example, including a channel BW of 20MHz, a channel BW of 40MHz, a channel BW of 80MHz, a channel BW of 160MHz, a channel BW of 320MHz, and/or any other additional or alternative channel BW, e.g., as described below.

[00106] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive a Physical Layer (PHY) Protocol Data Unit (PPDU) having a PPDU format (also referred to as "EHT PPDU format"), which may be configured, for example, for communication between EHT stations, e.g., as described below.

[00107] In some demonstrative embodiments, a PPDU, e.g., an EHT PPDU, may include at least one non-EHT field, e.g., a legacy field, which may be identified, decodable, and/or processed by one or more devices ("non-EHT devices", or "legacy devices"), which may not support one or more features and/or mechanisms ("non-legacy" mechanisms or "non-EHT mechanisms"). For example, the legacy devices may include non-EHT stations and/or non-High Throughput (HT) stations, which may be, for example, configured according to an *IEEE 802.11-2020 Standard*, and the like.

[00108] Reference is made to Fig. 2, which schematically illustrates an EHT PPDU format 200, which may be implemented in accordance with some demonstrative embodiments. In one example, devices 102 (Fig. 1) and/or 140 (Fig. 1) may be configured to generate, transmit, receive and/or process one or more EHT PPDUs having the structure and/or format of EHT PPDU 200.

[00109] In one example, devices 102 (Fig. 1) and/or 140 (Fig. 1) may communicate EHT PPDU 200, for example, as part of a transmission over a channel, e.g., an EHT channel, having a channel bandwidth including one or more 20MHz channels, for example, a channel BW of 20MHz, a channel BW of 40MHz, a channel BW of 80MHz, a channel BW of 160MHz, a channel BW of 320MHz, and/or any other additional or alternative channel BW, e.g., as described below.

[00110] In some demonstrative embodiments, EHT PPDU 200 may include an EHT SU PPDU, which may be utilized for transmission from an EHT STA, e.g., an EHT STA implemented by device 102 (Fig. 1), to one another STA, e.g., an EHT STA implemented by device 140 (Fig. 1).

[00111] In some demonstrative embodiments, EHT PPDU 200 may include an EHT MU PPDU, which may be utilized for transmission from an EHT STA, e.g., an EHT STA implemented by device 102 (Fig. 1), to one or more users, for example, one or more EHT STAs, including an EHT STA implemented by device 140 (Fig. 1).

[00112] In some demonstrative embodiments, as shown in Fig. 2, EHT PPDU 200 may include a non-High Throughput (non-HT) (legacy) Short Training Field (STF) (L-STF) 202, followed by a non-HT (Legacy) Long Training Field (LTF) (L-LTF) 204, which may be followed by a non-HT Signal (SIG) (L-SIG) field 206.

[00113] In some demonstrative embodiments, as shown in Fig. 2, EHT PPDU 200 may include a repeated non-HT SIG (RL-SIG) field 208, which may follow the L-SIG field 206. The RL-SIG field 208 may be followed by a Universal SIG (U-SIG) field 210.

[00114] In some demonstrative embodiments, as shown in Fig. 2, EHT PPDU 200 may include a plurality of EHT-modulated fields, e.g., following the U-SIG field 210.

[00115] In some demonstrative embodiments, as shown in Fig. 2, the EHT modulated fields may include, for example, an EHT Signal (EHT-SIG) field 212.

[00116] In some demonstrative embodiments, as shown in Fig. 2, the EHT modulated fields may include, for example, an EHT STF (EHT-STF) field 214, e.g., following the EHT-SIG field 212.

[00117] In some demonstrative embodiments, as shown in Fig. 2, the EHT modulated fields may include, for example, an EHT LTF (EHT-LTF) field 216, e.g., following the EHT-STF field 214.

[00118] In some demonstrative embodiments, as shown in Fig. 2, the EHT modulated fields may include, for example, a data field 218, e.g., following the EHT-LTF field 216, and/or a Packet Extension (PE) field 220, e.g., following the data field 218.

[00119] In some demonstrative embodiments, EHT PPDU 200 may include some or all of the fields shown in Fig. 2 and/or one or more other additional or alternative fields.

[00120] Referring back to Fig. 1, in some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, transmit, receive and/or process one or more transmissions, e.g., including one or more EHT PPDUs, e.g., as described below.

[00121] In some demonstrative embodiments, for example, devices 102 and/or 140 may be configured to perform one or more operations, and/or functionalities of an EHT STA, which may be configured, for example, to generate, transmit, receive and/or process one or more transmissions, e.g., including one or more EHT PPDUs, e.g., including one or more fields according to the EHT PPDU format of Fig. 2.

[00122] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, transmit, receive and/or process an EHT PPDU, e.g., in accordance with an *IEEE 802.11be Specification* and/or any other specification, e.g., as described below.

[00123] In some demonstrative embodiments, for example, devices 102 and/or 140 may be configured to perform one or more operations, and/or functionalities of an EHT STA, which may be configured, for example, to generate, transmit, receive and/or process the EHT PPDU as an EHT MU PPDU, for example, in accordance with the EHT PPDU formal 200 (Fig. 2).

[00124] In some demonstrative aspects, the EHT MU PPDU may include a PPDU that carries one or more PHY service data units (PSDUs) for one or more STAs using a downlink multi-user multiple input, multiple output (DL-MU-MIMO) technique, an orthogonal frequency division multiple access (DL OFDMA) technique, or a combination of the two techniques.

[00125] In some demonstrative embodiments, for example, devices 102 and/or 140 may be configured to perform one or more operations, and/or functionalities of an EHT STA, which may be configured, for example, to generate, transmit, receive and/or process the EHT MU PPDU, for example, over a 20MHz channel width, a 40MHz channel width, a 80MHz channel width, a 160MHz channel width, and/or a 320Mhz channel width.

[00126] In other embodiments, any other additional or alternative channel width may be utilized.

[00127] In some demonstrative embodiments, devices 102 and/or 140 may be configured to implement a mechanism for time allocation within a Transmit Opportunity (TxOP), e.g., as described below.

[00128] In some demonstrative embodiments, an AP STA, e.g., an AP STA implemented by device 140, may be configured to obtain a TxOP, for example, according to a channel access mechanism, for example, according to one or more channel access rules of an *IEEE 802.11 Specification*, and/or any other channel access rules and/or mechanisms.

[00129] In some demonstrative embodiments, devices 102 and/or 140 may be configured to implement a mechanism utilizing a trigger frame for time allocation within a TxOP, e.g., as described below.

[00130] For example, a trigger frame, e.g., in compliance with an *IEEE 802.11ax Specification*, may be utilized as a key tool to resolve a congestion issue resulting from multiple STAs contending for medium access in UL. For example, the AP may transmit a control frame, referred to as a Trigger frame (TF), granting UL frequency resources, e.g., in the form of Resource Units (RUs), to one or more STAs. After receiving this TF, the STAs that are addressed in the TF may respond with High Efficiency (HE) Trigger-Based (TB) PPDUs, for example, in the allocated RUs. Parameters of the TB PPDU transmission, for example, the duration of the TB PPDU transmission, a Modulation and Coding Scheme (MCS), a Number of Spatial Streams (NSS), and/or an UL Power to be used by such STAs, may be specified in the Trigger frame. According to this implementation, the duration of the TB PPDU transmission is required to exactly match the allocation time. As such, if the STA does not have enough data, it must pad the TB PPDU to align the TB PPDU length to the allocated time.

[00131] The efficiency of this triggered operation may rely on the AP accurately estimating a buffer status at the STA side, and calculating an optimal MCS, RU, and NSS to be used by the STA. In order to aid calculation of such estimate, a Buffer Status Report (BSR) may be employed, both solicited and unsolicited, to convey the actual queue size at the STA side.

[00132] The efficiency of the triggered operation may depend therefore also, on how good the AP is at computing the required UL resources and its scheduling policies. The additional mechanism such as solicited BSR adds overhead. On the other hand, if the BSR information is not recent, the allocation may not be efficient. This problem may even be higher in some cases, e.g., due to Multi Link Operation (MLO).

[00133] Because of the above issues, the adoption of triggered operation in real implementations has not been very high.

[00134] Reference is made to Fig. 3, which schematically illustrates communications between an Access Point (AP) Multi-Link Device (MLD) 340 and a non-AP MLD 302,

to illustrate technical issues, which may be addressed in accordance with some demonstrative embodiments.

[00135] For example, as shown in Fig 3, the AP MLD 340 may include a first AP, denoted AP1, and a second AP, denoted AP2; and/or the non-AP MLD 302 may include a first non-AP STA, denoted STA1, and a second non-AP STA, denoted STA2.

[00136] For example, as shown in Fig 3, the AP1 may communicate with the STA1 over a first link (link 1), and the AP2 may communicate with the STA2 over a second link (link 2).

[00137] For example, as shown in Fig. 3, the STA1 may initially report it has X packets to transmit in the UL. For example, as shown in Fig. 3, the STA1 may transmit to the AP1 an unsolicited BSR 314 with an indication of *queue size=X*.

[00138] However, the queue information of the STA1 as indicated by the BSR 314 may become outdated and/or inaccurate. For example, the BSR information may become outdated due to the MLO, e.g., as described below.

[00139] For example, the non-AP MLD 302 may move some packets from a queue of the STA2 to the queue of the STA1, e.g., due to failed packet transmissions on the link 2.

[00140] For example, as shown in Fig. 3, the STA2 may communicate with the AP2 one or more communications, e.g., including an UL data frame 312 from the STA2 to the AP2, and a Block Acknowledgement (BA) 316 from the AP2 to the STA2, e.g., to acknowledge the UL data frame 312. For example, the non-AP STA 302 may decide to move some UL data packets from the STA2 to the STA1, e.g., based on unsuccessful communication of the UL data packets over the link 2.

[00141] According to this example, the AP MLD 340 may not aware of the internal dequeuing/requeuing at the non-AP MLD 302, and the AP MLD 340 may continue to schedule UP transmissions from the non-AP MLD 302, e.g., based on the outdated queue information in the BSR frame 312. Accordingly, the AP MLD 340 may not be able to make an efficient allocation in a subsequent TF to the STA-1.

[00142] For example, as shown in Fig. 3, the AP MLD 340 may control the AP1 to transmit a TF 318 to allocate for the STA1 an UL transmission of a TB PPDU 32 including the *X* buffered packets indicated by the BSR frame 314. However, this

allocation, which is based on the outdated information in BSR frame 314, may not match the actual allocation which may be required by the STA1 for UL transmission.

[00143] Referring back to Fig. 1, in some demonstrative embodiments, devices 102 and/or 140 may be configured to implement a mechanism for time allocation, which may be configured to enhance single user Triggered operation, e.g., as described below.

[00144] In some demonstrative embodiments, devices 102 and/or 140 may be configured to implement a mechanism for time allocation, which may facilitate a simplified trigger operation that may provide a technical solution to reduce the burden at the AP side, for example, to compute resources to be allocated for triggered operation and, thereby, may provide a technical solution to increase chances of TF usage in a timeframe, for example, an IEEE 802.11be timeframe, e.g., as described below.

[00145] In some demonstrative embodiments, devices 102 and/or 140 may be configured to implement a mechanism for time allocation, which may facilitate a trigger frame (TF) mode that solicits single user (SU) Physical layer Protocol Data Units (PPDUs) from an addressed STA within an allocated time. This mechanism may provide a technical solution to provide more flexibility to a STA, for example, to select its own parameters in UL, and thereby, may provide a technical solution to significantly reduce computation complexity at the STA side, for example, with minimal spec changes, e.g., as described below.

[00146] In some demonstrative embodiments, an AP STA, e.g., an AP STA implemented by device 140, may be configured to allocate a time period within a TxOP of the AP STA to a non-AP STA, for example, a non-AP STA implemented by device 102, e.g., as described below.

[00147] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive one or more trigger frames, e.g., "light-weight" trigger frames, which may be configured to solicit single user (SU) physical layer protocol data units (PPDUs), e.g., as described below.

[00148] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive one or more trigger frames, e.g., "light-weight" trigger frames, which may be configured to support one or more, e.g., several, use-cases.

[00149] In some demonstrative embodiments, a SU PPDU triggering may facilitate that an AP transmits a Trigger Frame (TF), e.g., a SU-TF, which may elicit non-TB PPDUs from one or more triggered STAs, e.g., as described below.

[00150] In some demonstrative embodiments, a SU PPDU triggering may facilitate time allocation according to a mode or type (also referred to as "time allocation mode"), for example, which may be selected from a plurality of predefined modes, e.g., as described below.

[00151] In some demonstrative embodiments, the time allocation mode may include, for example, a mode ("Mode 1"), in which a triggered STA may transmit a PPDU with a duration matching the time allocated by the TF, e.g., as described below.

[00152] In some demonstrative embodiments, the time allocation mode may include, for example, a mode ("Mode 2"), in which the TF may allocate a maximal time to be used by the triggered STA for transmission of a PPDU, e.g., as described below.

[00153] In some demonstrative embodiments, the time allocation mode may include, for example, a mode ("Mode 3"), in which the TF may allocate a maximal time to be used for multiple PPDUs, e.g., as described below.

[00154] In some demonstrative aspects, the time allocation mode may be defined, for example, such that the non-AP STA is allowed to transmit PPDUs to the AP STA, which allocated the time allocation within the TxOP, e.g., as described below.

[00155] In some demonstrative aspects, the time allocation mode may be defined, for example, such that the non-AP STA is allowed to transmit PPDUs to one or more other STAs other than the AP STA, which allocated the time allocation within the TxOP. For example, the non-AP STA may be allowed to transmit PPDUs including Peer-to-Peer (P2P) frames to one or more other non-AP STAs, e.g., as described below.

[00156] In some demonstrative embodiments, a TF may be defined, e.g., in accordance with an *IEEE 802.11be Specification*, to trigger both High Efficiency (HE) STAs and EHT STAs. For example, signaling may be utilized, for example, in a user info field and/or any other field of the TF, to identify whether a user info field is to correspond to an HE STA or an EHT STA.

[00157] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive one or more trigger frames,

according to a time allocation mechanism, which may facilitate that the AP, e.g., device 140, can transmit a TF addressed to one STA, e.g., with only one User Info field in the TF, for example, such that the response to that TF is an SU PPDU and a duration of that frame transmission is less than or equal to the allocated time signaled in the Trigger frame, e.g., as described below.

[00158] In some demonstrative embodiments, the bandwidth (BW) of the frame transmission, e.g., the SU PPDU, may be equal to or lower than the one signaled in the TF, e.g., in an UL BW field (and/or its extensions) of the TF.

[00159] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive a trigger frame, which may be referred to as SU-TF, to trigger the time allocation for transmission of one or more SU non-TB PPDUs, e.g., as described below. This mechanism may be different, for example, from a mechanism, e.g., according to an *IEEE 802.11ax Specification*, which may utilize TFs with one User Info to solicit an HE TB PPDU.

[00160] In some demonstrative embodiments, controller 154 may be configured to trigger, cause, instruct and/or control device 140 to perform, one or more communications, to generate and/or communicate one or more messages and/or transmissions, and/or to perform one or more functionalities, operations and/or procedures, of an AP STA, e.g., as described below.

[00161] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to configure a trigger frame (TF) to include one user information (info) field addressed to a single non-AP STA, e.g., as described below.

[00162] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to configure the TF to include a single user info field. The single user info field may be addressed to a single non-AP STA, for example, to which a time allocation is to be allocated, e.g., as described below.

[00163] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to set a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a TxOP of the AP, e.g., as described below.

[00164] In some demonstrative embodiments, the allocated time may be configured for transmission of one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA, e.g., as described below.

[00165] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to transmit the trigger frame to initiate the allocation of the allocated time to the non-AP STA, e.g., as described below.

[00166] In some demonstrative embodiments, the trigger frame may include a control frame, e.g., as described below.

[00167] In other embodiments, the trigger frame may be implemented as part of any other type of frame.

[00168] In some demonstrative embodiments, the AP implemented by device 140 may include an EHT AP. In other aspects, any other type of AP STA may be used.

[00169] In some demonstrative embodiments, the allocated time may be configured for sequential transmission of PPDUs from the non-AP STA, e.g., as described below.

[00170] In some demonstrative embodiments, the one or more PPDUs may include non-Trigger-based (non-TB) PPDUs, e.g., as described below.

[00171] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to process a response frame from the non-AP STA in response to the trigger frame, e.g., as described below.

[00172] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to set a mode field in the common info field to indicate a type of the allocation of the allocated time for the non-AP STA, e.g., as described below.

[00173] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to set the mode field to a predefined mode value from a plurality of predefined mode values, e.g., as described below.

[00174] In some demonstrative embodiments, the plurality of predefined mode values may indicate a respective plurality of allocation modes, e.g., as described below.

[00175] In some demonstrative embodiments, the plurality of predefined mode values may include at least two mode values to indicate at least two respective allocation modes, e.g., as described below.

[00176] In some demonstrative embodiments, the plurality of predefined mode values may include three mode values to indicate three respective allocation modes, e.g., as described below.

[00177] In other embodiments, any other number of modes may be implemented.

[00178] In some demonstrative embodiments, the plurality of predefined mode values may include, for example, a first mode value and a second mode value, e.g., as described below.

[00179] In some demonstrative embodiments, the plurality of predefined mode values may include a first mode value to indicate an Uplink (UL) mode (any other name may be used for this mode), in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, e.g., as described below.

[00180] In some demonstrative embodiments, the plurality of predefined mode values may include a second mode value to indicate a Peer-to Peer (P2P) mode (any other name may be used for this mode), in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA, e.g., as described below.

[00181] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to set a mode field in the common info filed of the trigger frame to indicate a mode, e.g., the Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, e.g., as described below.

[00182] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to set a mode field in the common info filed of the trigger frame to indicate a mode, e.g., the Peer-to-Peer(P2P) mode, in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs, during the allocated time for the non-AP STA, e.g., as described below.

[00183] In other embodiments, any other additional or alternative modes may be implemented.

[00184] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to set a field in the trigger frame to indicate a length of the allocated time, e.g., as described below.

[00185] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to transmit a Block Acknowledgement (BA) to the non-AP STA based on a PPDU received from the non-AP STA during the allocated time, e.g., as described below.

[00186] In some demonstrative embodiments, controller 154 may be configured to enable the AP STA implemented by device 140 to transmit a frame a predefined Inter-Frame-Space (IFS) after a PPDU from the non-AP STA during the allocated time, e.g., as described below.

[00187] In some demonstrative embodiments, controller 154 may be configured to allow the AP STA implemented by device 140 to perform a transmission before an end of the allocated time for the non-AP STA, e.g., as described below.

[00188] In some demonstrative embodiments, controller 154 may be configured to cause the AP STA implemented by device 140 to perform a transmission before an end of the allocated time for the non-AP STA based on a Point-Inter-Frame-Space (PIFS) idle rule, e.g., as described below.

[00189] In some demonstrative embodiments, controller 124 may be configured to trigger, cause, instruct and/or control device 102 to perform, one or more communications, to generate and/or communicate one or more messages and/or transmissions, and/or to perform one or more functionalities, operations and/or procedures, of a non-AP STA, e.g., as described below.

[00190] In some demonstrative embodiments, the non-AP STA implemented by device 102 may include an EHT non-AP STA. In other aspects, any other type of non-AP STA may be used.

[00191] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to process a trigger frame received from an AP STA.

[00192] For example, the trigger frame received by the non-AP STA implemented by device 102 may include the trigger frame transmitted by the AP STA implemented by device 140, e.g., as described above.

[00193] In some demonstrative embodiments, the trigger frame may include a control frame, e.g., as described below.

[00194] In other embodiments, the trigger frame may be implemented as part of any other type of frame.

[00195] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to process the trigger frame from the AP to identify that the trigger frame includes one user info field, e.g., a single user info field, which is addressed to the non-AP STA implemented by device 102, e.g., as described below.

[00196] For example, controller 124 may be configured to cause the non-AP STA implemented by device 102 to identify that the single user info field in the TF is addressed to the non-AP STA implemented by device 102, e.g., as described below.

[00197] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to identify that the trigger frame is to allocate an allocated time for the non-AP STA implemented by device 102 within a TxOP of the AP, e.g., as described below.

[00198] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to identify based on a common info field of the trigger frame that the trigger frame is to allocate the allocated time for the non-AP STA within the TxOP of the AP, e.g., as described below.

[00199] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to transmit one or more PPDUs from the non-AP STA implemented by device 102 during the allocated time for the non-AP STA implemented by device 102, e.g., as described below.

[00200] In some demonstrative embodiments, controller 124 may be configured to allow the non-AP STA implemented by device 102 to perform sequential transmission of PPDUs during the allocated time for the non-AP STA, e.g., as described below.

[00201] In some demonstrative embodiments, the one or more PPDUs may include non-TB PPDUs., e.g., as described below.

[00202] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to transmit a response to the AP in response to the trigger frame, e.g., as described below.

[00203] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to process a mode field in the trigger frame, and to determine a type of the allocation of the allocated time for the non-AP STA, for example, based on the mode field, e.g., as described below.

[00204] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to determine the type of the allocation of the allocated time for the non-AP STA, for example, based on a determination that the mode field includes a mode value from a plurality of predefined mode values. For example, the plurality of predefined mode values may be configured to indicate a respective plurality of allocation modes, e.g., as described below.

[00205] In some demonstrative embodiments, the plurality of predefined mode values may include at least two mode values to indicate at least two respective allocation modes, e.g., as described below.

[00206] In some demonstrative embodiments, the plurality of predefined mode values may include three mode values to indicate three respective allocation modes, e.g., as described below.

[00207] In other embodiments, any other number of modes may be defined.

[00208] In some demonstrative embodiments, the plurality of predefined mode values may include a first mode value and a second mode value, e.g., as described below.

[00209] In some demonstrative embodiments, the first mode value may be configured to indicate a first mode, e.g., the UL mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, e.g., as described below.

[00210] In some demonstrative embodiments, the second mode value may be configured to indicate the P2P mode, in which the non-AP STA is allowed to transmit

PPDUs to other non-AP STAs during the allocated time for the non-AP STA, e.g., as described below.

[00211] In other embodiments, any other additional or alternative modes may be implemented.

[00212] In some demonstrative embodiments, controller 124 may be configured to allow and/or enable the non-AP STA implemented by device 102 to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, for example, based on a determination that a mode field in the common info field of the trigger frame indicates the UL mode, e.g., as described below.

[00213] In some demonstrative embodiments, controller 124 may be configured to prohibit, prevent, and/or disable the non-AP STA implemented by device 102 from transmitting PPDUs to other non-AP STAs, e.g., P2P PPDUs, during the allocated time for the non-AP STA, for example, based on a determination that the mode field in the common info field of the trigger frame indicates the UL mode, e.g., as described below.

[00214] In some demonstrative embodiments, controller 124 may be configured to allow and/or enable the non-AP STA implemented by device 102 to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA, for example, based on a determination that a mode field in the common info field of the trigger frame indicates the P2P mode, e.g., as described below.

[00215] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to identify a length of the allocated time based on a field in the trigger frame, e.g., as described below.

[00216] In some demonstrative embodiments, controller 124 may be configured to cause the non-AP STA implemented by device 102 to process a BA based on a PPDU transmitted from the non-AP STA during the allocated time, e.g., as described below.

[00217] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications for communication during a time allocation within a TxOP according to one or more modes, e.g., as described below.

[00218] In some demonstrative embodiments, the SU-TF may be classified into one or more of types/modes described below, for example, to address different use-cases.

[00219] In some demonstrative embodiments, some fields such as, for example, MCS, Spatial Stream (SS) Allocation, and/or RU allocation, may be reserved, e.g., for some or all of the modes.

[00220] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications according to a time allocation mode, which may be configured such that duration of the SU PPDU transmission matches the allocated time. In one example, this type of time allocation may be useful, for example, when the SU-TF is used to create or maintain alignment for synchronous PPDU (including one containing Ctrl frames) transmissions occurring on multiple links.

[00221] In some demonstrative embodiments, for example, the AP may be allowed to transmit a frame an IFS, e.g., a Short IFS (SIFS) after the SU PPDU transmission.

[00222] Reference is made to Fig. 4, which schematically illustrates a time allocation within a TxOP, in accordance with some demonstrative embodiments. For example, device 102 (Fig. 1) and/or device 140 (Fig. 1) may be configured to perform one or more communications and/or operations according to Fig. 4.

[00223] In some demonstrative embodiments, as shown in Fig. 4, an AP may transmit a trigger frame 412, e.g., a SU-TF, to a STA. For example, controller 154 (Fig. 1) may be configured to trigger, cause, instruct and/or control device 140 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the AP. For example, controller 124 (Fig. 1) may be configured to trigger, cause, instruct and/or control device 102 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the STA.

[00224] In some demonstrative embodiments, the trigger frame 412 may include an indication of a time allocation 416 to be allocated to the STA, e.g., within a TxOP 410 of the AP.

[00225] In some demonstrative embodiments, the trigger frame 412 may include an indication to indicate whether the time allocation 416 is allocated for a fixed PPDU duration. For example, as shown in Fig. 4, the trigger frame 412 may include an indication that the time allocation is 416 is allocated for transmission of a PPDU with a fixed length corresponding to the duration, denoted T, of the time allocation 416.

[00226] In some demonstrative embodiments, the STA may receive and process the trigger frame 412.

[00227] In some demonstrative embodiments, as shown in Fig. 4, the STA may transmit a PPDU 418 to the AP during the allocated time 416. For example, as shown in Fig. 4, based on the indication in trigger frame 412, the STA may configure the PPDU 418 as a SU PPDU with a fixed duration based on the duration of the time allocation 416, e.g., such that transmission of the PPDU 418 will end at an end of the time allocation 416.

[00228] In some demonstrative embodiments, as shown in Fig. 4, the AP may receive and process the PPDU 418, and may transmit a BA 420 to the STA, e.g., to acknowledge the PPDU 418.

[00229] Referring back to Fig. 1, in some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications according to a time allocation mode, which may be configured such that the allocated time, which is allocated by the trigger frame, indicates the maximum SU PPDU transmission time, and, possibly, a corresponding response PPDU length. For example, the AP may be allowed to transmit a frame an IFS, e.g., as SIFS, after the SU PPDU transmission plus the corresponding BA. In one example, this type of time allocation may be useful, for example, for soliciting Data frames.

[00230] Reference is made to Fig. 5, which schematically illustrates a time allocation within a TxOP, in accordance with some demonstrative embodiments. For example, device 102 (Fig. 1) and/or device 140 (Fig. 1) may be configured to perform one or more communications and/or operations according to Fig. 5.

[00231] In some demonstrative embodiments, as shown in Fig. 5, an AP may transmit a trigger frame 512, e.g., a SU-TF, to a STA. For example, controller 154 (Fig. 1) may be configured to trigger, cause, instruct and/or control device 140 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the AP. For example, controller 124 (Fig. 1) may be configured to trigger, cause, instruct and/or control device 102 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the STA.

[00232] In some demonstrative embodiments, the trigger frame 512 may include an indication of a time allocation 516 to be allocated to the STA, e.g., within a TxOP 510 of the AP.

[00233] In some demonstrative embodiments, the trigger frame 512 may include an indication to indicate that the time allocation 516 is allocated for a duration during which the STA is allowed to an UL PPDU with the AP. For example, as shown in Fig. 5, the trigger frame 512 may include an indication that the time allocation is 516 is allocated for transmission of an UL PPDU during the duration, denoted *T*, of the time allocation 516.

[00234] In some demonstrative embodiments, the STA may receive and process the trigger frame 512.

[00235] In some demonstrative embodiments, as shown in Fig. 5, the STA may transmit a PPDU 518 to the AP during the allocated time 516. For example, as shown in Fig. 5, based on the indication in trigger frame 512, the STA may configure the PPDU 518 as a SU PPDU, which may be transmitted during the duration of the time allocation 516.

[00236] In some demonstrative embodiments, as shown in Fig. 5, the AP may receive and process the PPDU 518, and may transmit a BA 520 to the STA, e.g., to acknowledge the PPDU 518.

[00237] In some demonstrative embodiments, as shown in Fig. 5, the AP may use any unused time of the allocated time 516, e.g., for its own use. For example, as shown in Fig, 5, the AP may begin transmission of a DL data transmission 522, e.g., before an end of the allocated time 516.

[00238] Referring back to Fig. 1, in some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications according to a time allocation mode, which may be configured such that the allocated time, which is allocated by the trigger frame, indicates a maximum time within which multiple SU PPDU transmissions and, possibly, the corresponding response PPDU length, should be completed. In one example, this implementation may be a generalization of the time allocation mode described above with reference to Fig. 5.

[00239] In one example, this type of time allocation may be useful, for example, when the AP does not require the triggered STA to transmit only UL packets. For example, the triggered STA may be allowed to use this time allocation for any peer-to-peer link in which that STA is a member, or in which a STA collocated with that STA on the same channel is a member.

[00240] In some demonstrative embodiments, the STA may be configured to explicitly signal that it does not have any more UL packets to transmit.

[00241] In one example, the STA can signal that it does not have any more UL packets to transmit, for example, by transmitting an explicit frame, e.g., a Contention Free (CF) end (CF-end) frame, a Quality of Service (QoS) Null frame, and/or any other frame.

[00242] In another example, the STA can signal that it does not have any more UL packets to transmit, for example, via an existing field in the transmitted data frame, e.g., a More Data bit, and/or any other field.

[00243] In some demonstrative embodiments, the AP may regain access to the medium, for example, based on receipt of the signaling form the STA that it does not have any more UL packets to transmit.

[00244] In some demonstrative embodiments, for example, for a P2P case in which the allocated time allows P2P communication, the AP may simply relinquish control of the rest of the TxOP. According to this implementation, the AP may not need to regain control of the medium during the rest of the TXOP.

[00245] In some demonstrative embodiments, by transmitting the SU-TF, the AP may transfer ownership of TxOP to the STA, for example, by providing full control over the TxOP to the STA addressed by the TF. For example, the STA may be responsible for any error recovery or release of unused part of medium. This implementation may possibly be considered as another mode, e.g., a "Mode 4".

[00246] Reference is made to Fig. 6, which schematically illustrates a time allocation within a TxOP, in accordance with some demonstrative embodiments. For example, device 102 (Fig. 1) and/or device 140 (Fig. 1) may be configured to perform one or more communications and/or operations according to Fig. 6.

[00247] In some demonstrative embodiments, as shown in Fig. 6, an AP may transmit a trigger frame 612, e.g., a SU-TF, to a STA. For example, controller 154 (Fig. 1) may

be configured to trigger, cause, instruct and/or control device 140 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the AP. For example, controller 124 (Fig. 1) may be configured to trigger, cause, instruct and/or control device 102 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the STA.

[00248] In some demonstrative embodiments, the trigger frame 612 may include an indication of a time allocation 616 to be allocated to the STA, e.g., within a TxOP 610 of the AP.

[00249] In some demonstrative embodiments, the trigger frame 612 may include an indication to indicate that the time allocation 616 is allocated for a duration during which the STA is allowed to communicate one or more communications with the AP. For example, as shown in Fig. 6, the trigger frame 612 may include an indication that the time allocation is 616 is allocated for transmission of one or more PPDUs, e.g., multiple PPDUs, during the duration, denoted T, of the time allocation 616. For example, as shown in Fig. 6, the trigger frame 612 may include an indication of an UL mode, e.g., a no-P2P mode, during which the STA is allowed to transmit one or more UL PPDUs, e.g., multiple PPDUs, to the AP.

[00250] In some demonstrative embodiments, the STA may receive and process the trigger frame 612.

[00251] In some demonstrative embodiments, as shown in Fig. 6, the STA may transmit a first PPDU 620 to the AP during the allocated time 616. For example, as shown in Fig. 6, based on the indication in trigger frame 612, the STA may configure the PPDU 618 as a SU PPDU, which may be transmitted during the duration of the time allocation 616.

[00252] In some demonstrative embodiments, as shown in Fig. 6, the AP may receive and process the PPDU 618, and may transmit a BA 620 to the STA, e.g., to acknowledge the PPDU 618.

[00253] In some demonstrative embodiments, as shown in Fig. 6, the STA may transmit a second PPDU 622 to the AP during the allocated time 616. For example, as shown in Fig. 6, based on the indication in trigger frame 612, the STA may configure the PPDU 622 as a SU PPDU, which may be transmitted during the duration of the time

allocation 616. For example, as shown in Fig. 6, the STA may include in PPDU 622 an indication, e.g., in the form of an indication *"More Data=0"* or any other indication, that the STA has no more UL data to transmit to the AP during the allocated time 616.

[00254] In some demonstrative embodiments, as shown in Fig. 6, the AP may receive and process the PPDU 622, and may transmit a BA 624 to the STA, e.g., to acknowledge the PPDU 620.

[00255] In some demonstrative embodiments, as shown in Fig. 6, the AP may use any unused time of the allocated time 616, e.g., for its own use. For example, as shown in Fig, 6, the AP may begin transmission of a DL data transmission 626, e.g., before an end of the allocated time 616.

[00256] Reference is made to Fig. 7, which schematically illustrates a time allocation within a TxOP, in accordance with some demonstrative embodiments. For example, device 102 (Fig. 1) and/or device 140 (Fig. 1) may be configured to perform one or more communications and/or operations according to Fig. 7.

[00257] In some demonstrative embodiments, as shown in Fig. 7, an AP may transmit a trigger frame 712, e.g., a SU-TF, to a STA. For example, controller 154 (Fig. 1) may be configured to trigger, cause, instruct and/or control device 140 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the AP. For example, controller 124 (Fig. 1) may be configured to trigger, cause, instruct and/or control device 102 (Fig. 1) to perform a role of, one or more operations of, and/or functionalities of, the STA.

[00258] In some demonstrative embodiments, the trigger frame 712 may include an indication of a time allocation 716 to be allocated to the STA, e.g., within a TxOP 710 of the AP.

[00259] In some demonstrative embodiments, the trigger frame 712 may include an indication to indicate that the time allocation 716 is allocated for a duration during which the STA is allowed to communicate one or more communications with the AP. For example, as shown in Fig. 7, the trigger frame 712 may include an indication that the time allocation is 716 is allocated for transmission of one or more PPDUs, e.g., multiple PPDUs, during the duration, denoted T, of the time allocation 716. For example, as shown in Fig. 7, the trigger frame 712 may include an indication of a P2P

mode, during which the STA is allowed to transmit one or more UL PPDUs to the AP and/or one or more P2P PPDUs to one or more other STAs. For example, the trigger frame 712 may indicate that the AP allocates the remaining TxOP 710 entirely to the STA, e.g., for its own transmission of UL and/or P2P PPDU communications.

[00260] In some demonstrative embodiments, the STA may receive and process the trigger frame 712.

[00261] In some demonstrative embodiments, as shown in Fig. 7, the STA may transmit a first PPDU 718 to another STA during the allocated time 716. For example, as shown in Fig. 7, based on the indication in trigger frame 712, the STA may configure the PPDU 718 as a SU P2P PPDU, which may be transmitted during the duration of the time allocation 716.

[00262] In some demonstrative embodiments, as shown in Fig. 7, the STA may receive and process a BA 720 from the other STA, e.g., to acknowledge the PPDU 718.

[00263] In some demonstrative embodiments, as shown in Fig. 7, the STA may transmit a second PPDU 722 to the AP during the allocated time 716. For example, as shown in Fig. 7, based on the indication in trigger frame 712, the STA may configure the PPDU 722 as a SU P2P PPDU, which may be transmitted during the duration of the time allocation 716.

[00264] In some demonstrative embodiments, as shown in Fig. 7, the STA may receive and process a BA 724 from an other STA, e.g., to acknowledge the PPDU 722.

[00265] Referring back to Fig. 1, in some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications according to a time allocation mode, which may be configured according to one or more allocation, signaling, and/or communication rules, e.g., as described below.

[00266] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive a trigger frame including one or more reserved Trigger Type subfields, which may be used to signal that the trigger frame is to be handled as a trigger frame, e.g., an SU-TF, which is to schedule the time allocation to a non-AP STA, e.g., as described above.

[00267] In some demonstrative embodiments, a Trigger Dependent Common Info field may be present in the trigger frame, for example, to signal the modes of the SU-TF.

[00268] In some demonstrative embodiments, the Trigger Dependent User Info may be present and may be set to signal the mode of the time allocation according to the SU-TF, e.g., as described above.

[00269] In some demonstrative embodiments, the mode of the time allocation, e.g., as described above, may be signaled in the User Info field.

[00270] In other embodiments, the mode of the time allocation may be signaled using any other additional or alternative fields.

[00271] In some demonstrative embodiments, one or more of the reserved bits in the Common Info field may be reused to signal the SU-TF, and its different modes.

[00272] Reference is made to Fig. 8, which schematically illustrates fields in a common information (info) field 800, in accordance with some demonstrative embodiments. For example, device 102 (Fig. 1) and/or device 140 (Fig. 1) may be configured to generate, process, transmit and/or receive a trigger frame including one or more of the fields of common info field 800.

[00273] In some demonstrative embodiments, as shown in Fig. 8, the common info field 800 of the trigger frame may include a field 802 ("TF mode field", "mode of TF", or "mode of SU-TF), which may be set to indicate a mode of the trigger frame.

[00274] In some demonstrative embodiments, as shown in Fig. 8, the TF mode field 802 may include three bits.

[00275] In other embodiments, the TF mode field 802 may include any other number of bits, e.g., one bit, two bits, or any other number of bits.

[00276] In some demonstrative embodiments, as shown in Fig. 8, the TF mode field 802 may be implemented by setting one or more reserved bits of the common info field 800. In other embodiments, any other, e.g., dedicated or new, bits may be used.

[00277] In some demonstrative embodiments, an AP STA, e.g., the AP STA implemented by device 140 (Fig. 1), may be configured to set the TF mode field 802 in the common info field 800 to a value which may indicate that a trigger frame including

the common info field 800 is to allocate an allocated time for a non-AP STA within a TxOP of the AP, e.g., as described above.

[00278] In some demonstrative embodiments, the TF mode field 802 may be set to a first predefined value, e.g., zero or any other value, to indicate no SU-TF.

[00279] In some demonstrative embodiments, the TF mode field 802 may be set to a first predefined value, e.g., zero or any other value, to indicate that the trigger frame is not to be handled as a trigger frame, e.g., an SU-TF, which is to allocate an allocated time for a non-AP STA within a TxOP of the AP.

[00280] In some demonstrative embodiments, the TF mode field 802 may be set to a second predefined value, e.g., a non-zero value or any other value, to indicate a SU-TF.

[00281] In some demonstrative embodiments, the TF mode field 802 may be set to a second predefined value, e.g., a non-zero value or any other value, to indicate that the trigger frame is to be handled as a trigger frame, e.g., an SU-TF, which is to allocate an allocated time for a non-AP STA within a TxOP of the AP.

[00282] In some demonstrative embodiments, the TF mode field 802 may be set to a value, e.g., a non-zero value, or any other value, according to the mode of the time allocation to be allocated by the trigger frame.

[00283] In some demonstrative embodiments, the TF mode field 802 may be set to a first mode value, e.g., a first non-zero value, e.g., 1, to indicate a first mode of the time allocation, e.g., as described above.

[00284] In some demonstrative embodiments, the TF mode field 802 may be set to a second mode value, e.g., a second non-zero value, e.g., 2, to indicate a second mode of the time allocation, e.g., as described above.

[00285] In some demonstrative embodiments, the signaling that a trigger frame is to be handled as a trigger frame, e.g., an SU-TF, which is to allocate an allocated time for a non-AP STA within a TxOP of the AP, and/or the signaling to indicate the mode of the time allocation, may be implemented using any other additional or alternative fields, e.g., as described below.

[00286] In some demonstrative embodiments, a new User Info with a specific Association ID (AID) value, e.g., an AID12 value, may be configured to contain

additional Common Info parameters, which may be used to signal the SU-TF and/or the mode of the time allocation.

[00287] In some demonstrative embodiments, one or more sub-fields in the User Info field may be used to signal that the trigger frame is to be handled as a trigger frame, e.g., an SU-TF, which is to allocate an allocated time for a non-AP STA within a TxOP of the AP, and/or the mode of the time allocation, e.g., as described below.

[00288] Reference is made to Fig. 9, which schematically illustrates fields in a user info field 900, in accordance with some demonstrative embodiments. For example, device 102 (Fig. 1) and/or device 140 (Fig. 1) may be configured to generate, process, transmit and/or receive a trigger frame including one or more of the fields of user info field 900.

[00289] In some demonstrative embodiments, as shown in Fig. 9, a field of the user info field 900, e.g., a field 902, which may be otherwise used as an AID field, and may be reserved for unicast TFs. For example, the AID12 field may be redefined to signal the SU-TF and/o the time allocation mode, e.g., as described below.

[00290] In some demonstrative embodiments, as shown in Fig. 9, the field 902 may be configured as a TF mode field ("mode of TF", or "mode of SU-TF), which may be set to indicate a mode of the trigger frame.

[00291] In some demonstrative embodiments, as shown in Fig. 9, the TF mode field 902 may include up to four bits.

[00292] In other embodiments, the TF mode field 902 may include any other number of bits, e.g., one bit, two bits, three bits, or any other number of bits.

[00293] In some demonstrative embodiments, an AP STA, e.g., the AP STA implemented by device 140 (Fig. 1), may be configured to set the TF mode field 902 in user info field 900 to a value which may indicate that a trigger frame including the user info field 900 is to allocate an allocated time for a non-AP STA within a TxOP of the AP, e.g., as described above.

[00294] In some demonstrative embodiments, the TF mode field 902 may be set to a first predefined value, e.g., zero or any other value, to indicate no SU-TF.

[00295] In some demonstrative embodiments, the TF mode field 902 may be set to a first predefined value, e.g., zero or any other value, to indicate that the trigger frame is not to be handled as a trigger frame, e.g., an SU-TF, which is to allocate an allocated time for a non-AP STA within a TxOP of the AP.

[00296] In some demonstrative embodiments, the TF mode field 902 may be set to a second predefined value, e.g., a non-zero value or any other value, to indicate a SU-TF.

[00297] In some demonstrative embodiments, the TF mode field 902 may be set to a second predefined value, e.g., a non-zero value or any other value, to indicate that the trigger frame is to be handled as a trigger frame, e.g., an SU-TF, which is to allocate an allocated time for a non-AP STA within a TxOP of the AP.

[00298] In some demonstrative embodiments, the TF mode field 902 may be set to a value, e.g., a non-zero value, or any other value, according to the mode of the time allocation to be allocated by the trigger frame.

[00299] In some demonstrative embodiments, the TF mode field 902 may be set to a first mode value, e.g., a first non-zero value, e.g., 1, to indicate a first mode of the time allocation, e.g., as described above.

[00300] In some demonstrative embodiments, the TF mode field 902 may be set to a second mode value, e.g., a second non-zero value, e.g., 2, to indicate a second mode of the time allocation, e.g., as described above.

[00301] Referring back to Fig. 1, in some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications according to a time allocation mode, which may be configured according to one or more error recovery rules, e.g., as described below.

[00302] In some demonstrative embodiments, a baseline TxPIFS rule may be adopted, for example, with respect to the Mode 1 and Mode 2 time allocations, e.g., as described above. For example, the AP, which transmits the trigger frame to allocate the time allocation, may regain access to the TxOP, for example, if the AP hears the medium to be idle after TxPIFS.

[00303] In some demonstrative embodiments, in some implementations, a baseline TxPIFS rule may be adopted, for example, if the medium is idle for PIFS after transmission of the SU-TF. For example, this recovery rule may be implemented for

the Mode 3 time allocation, e.g., as described above, and/or for time allocations when there is no restriction on whom the STA can transmit.

[00304] In some demonstrative embodiments, the AP, e.g., device 140, may be allowed to regain access to the wireless medium, for example, anytime when the AP perceives the medium to be idle during the allocated time. This recovery rule may be implemented, for example, with respect to the Mode 3 time allocation, e.g., as described above. For example, any STA besides the AP can already gain access to medium during the allocated time, for example, if the Network Allocation vector (NAV) is not set.

[00305] In some demonstrative embodiments, the AP, e.g., device 140, may require the triggered STA, e.g., device 102, to initiate transmission by a frame whose NAV value indicates the Duration for which the STA is going to use the allocation. The AP may be allowed to regain the medium at the end of the updated allocation, for example, by SIFS or a regular Enhanced Distributed Channel Access (EDCA) mechanism. This recovery rule may be implemented, for example, with respect to the Mode 3 time allocation, e.g., as described above.

[00306] In some demonstrative embodiments, an AP, e.g., device 140, may be configured to transmit a trigger frame, e.g., a SU-TF, where a time value signaled in the Duration field of the SU-TF may be lower than the actual time allocation, e.g., as indicated by the UL Length field, to a triggered STA, e.g., device 102. For example, the STA may be allowed to use this information to determine that the AP has relinquished a rest of the TxOP to the STA. This recovery rule may be implemented, for example, with respect to the Mode 3 time allocation, e.g., as described above.

[00307] In some demonstrative embodiments, an AP, e.g., device 140, may decide to relinquish a remainder of the TxOP. For example, the AP may signal this decision as a separate value of a "Mode for SU-TF" field, e.g., by setting the TF mode field to a predefined value to indicate that the trigger frame is to relinquish the remainder of the TxOP.

[00308] In some demonstrative embodiments, a lowest Access Category (AC) corresponding to the QoS Data frames transmitted within the allocation time may be signaled, for example, in a Preferred AC field of the SU-TF, and/or in any other field.

[00309] In some demonstrative embodiments, a STA, e.g., device 102, which receives the trigger frame allocating the allocated time to the STA, may be allowed to use a lower Bandwidth (BW) than a BW indicated, for example, in an UL BW length field of the trigger frame. For example, the STA maty use the lower BW if corresponding secondary channels are busy.

[00310] In some demonstrative embodiments, the allocated time may be initiated by a trigger frame, e.g., as described above.

[00311] In other embodiments, any other frame, e.g., a control frame or any other type of frame, may be used.

[00312] In some demonstrative embodiments, a new Control frame or an existing one, e.g., a CF-Poll frame, may be used to signal the SU-TF, e.g., in a lightweight manner.

[00313] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications according to a Target Wake Time (TWT) mechanism, e.g., as described below.

[00314] For example, a TWT mechanism may be utilized in order to define restrictions on EDCA, for example, during a specific protected service period (SP).

[00315] For example, a restricted TWT mechanism may be configured to define that all EHT STAs associated to an AP advertising a restricted TWT shall end their TxOP before the start of the restricted TWT.

[00316] For example, the restricted TWT mechanism may be configured to define that EHT STAs that negotiated with the AP to be part/member of the restricted TWT can transmit without restrictions during the restricted TWT, for example, except for rules defined in the restricted TWT membership during negotiation, e.g., a specific TID, triggered access, and/or any other restrictions and/or criteria.

[00317] For example, the restricted TWT mechanism may be configured to define that EHT STAs that are not a member of the restricted TWT may have to follow other restrictions, for example, these STAs shall not transmit during the duration of the restricted TWT period.

[00318] For example, some implementations may base signaling and/or negotiation on the TWT mechanism, for example, by relying on a broadcast TWT so that the restricted TWT are advertised by the AP, e.g., in beacons.

[00319] In some demonstrative embodiments, signaling of broadcast TWT may be configured, e.g., extended, for example, so that it is possible to advertise the TWT SPs in the form of a bitmap, e.g., as described below.

[00320] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications, which may indicate and/or define one or more TWTs, e.g., restricted TWTs, according to a bitmap, e.g., as described below.

[00321] In some demonstrative embodiments, devices 102 and/or 140 may be configured to generate, process, transmit and/or receive communications according to a broadcast TWT mechanism, which may use broadcast TWT so that an AP can specify service periods during which restrictions may be defined for associated STAs.

[00322] In some demonstrative embodiments, a bitmap may be defined with multiple slots/service periods, for example, where each slot has a BCST TWT ID that starts at 1 and increments each slot, e.g., as described below.

[00323] In some demonstrative embodiments, the plurality of slots/periods may be signaled using a broadcast TWT, for example, by sending a broadcast TWT element for the first slot with ID1, and including a bitmap to corresponding to the slots/periods, e.g., as described below.

[00324] In some demonstrative embodiments, controller 154 may be configured to trigger, cause, instruct and/or control device 140 to perform, one or more communications, to generate and/or communicate one or more messages and/or transmissions, and/or to perform one or more functionalities, operations and/or procedures, of an EHT STA, which may be configured to generate and transmit a TWT element including a bitmap corresponding to a plurality of TWT periods, e.g., as described below.

[00325] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to configure a bitmap including a

plurality of bits corresponding to a respective plurality of Target Wake Time (TWT) periods, e.g., as described below.

[00326] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to set a bit in the bitmap corresponding to a TWT period to 1, for example, to indicate that there is at least one STA associated with the TWT period, e.g., as described below.

[00327] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to transmit a Broadcast (BC) TWT element including the bitmap, e.g., as described below.

[00328] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to set another bit in the bitmap corresponding to another TWT period to 0, for example, to indicate that there is no STA associated with the other TWT period, e.g., as described below.

[00329] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to set a field in the BC TWT element to indicate that information in one more fields of the BC TWT element relates to a first-in-order TWT period of the plurality of TWT periods, e.g., as described below.

[00330] In some demonstrative embodiments, the field in the BC TWT element may include a one-bit field, e.g., as described below. In other embodiments, any other field may be used to indicate that information in one more fields of the BC TWT element relates to a first-in-order TWT period of the plurality of TWT periods.

[00331] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to set a duration field in the BC TWT element to indicate a duration of all of the plurality of TWT periods, e.g., as described below.

[00332] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to set a TWT interval field in the BC TWT element to indicate a Service Period (SP) periodicity corresponding to the plurality of TWT periods, e.g., as described below.

[00333] In some demonstrative embodiments, controller 154 may be configured to cause the EHTP STA implemented by device 140 to set a TWT field in the BC TWT

element to indicate a beginning of a first-in-order TWT period of the plurality of TWT periods, e.g., as described below.

[00334] In some demonstrative embodiments, controller 124 may be configured to trigger, cause, instruct and/or control device 102 to perform, one or more communications, to generate and/or communicate one or more messages and/or transmissions, and/or to perform one or more functionalities, operations and/or procedures, of an EHT STA, which may be configured to receive and process a TWT element including a bitmap corresponding to a plurality of TWT periods, e.g., as described below.

[00335] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to process a bitmap in a received BC TWT element, e.g., as described below.

[00336] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to receive and process the BC TWT element received from the EHT STA implemented by device 140.

[00337] In some demonstrative embodiments, the bitmap may include a plurality of bits corresponding to a respective plurality of TWT periods, e.g., as described below.

[00338] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to identify that there is at least one STA associated with the TWT period, for example, based on a determination that a bit in the bitmap corresponding to a TWT period is set to 1, e.g., as described below.

[00339] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to determine that there is no STA associated with another TWT period, for example, based on a determination that another bit in the bitmap corresponding to the other TWT period is set to 0, e.g., as described below.

[00340] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to process information in one more fields of the BC TWT element with relation to a first-in-order TWT period of the plurality of TWT periods, for example, based on a field in the BC TWT element, e.g., as described below.

[00341] In some demonstrative embodiments, the field in the BC TWT element may include a one-bit field, e.g., as described below.

[00342] In other embodiments, any other field may be used to determine that information in one more fields of the BC TWT element is to be processed with relation to a first-in-order TWT period of the plurality of TWT periods.

[00343] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to determine a duration of all of the plurality of TWT periods, for example, based on a duration field in the BC TWT element, e.g., as described below.

[00344] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to determine a SP periodicity corresponding to the plurality of TWT periods, for example, based on a TWT interval field in the BC TWT element, e.g., as described below.

[00345] In some demonstrative embodiments, controller 124 may be configured to cause the EHT STA implemented by device 102 to determine a beginning of a first-in-order TWT period of the plurality of TWT periods, for example, based on a TWT field in the BC TWT element, e.g., as described below.

[00346] In some demonstrative embodiments, a TWT mechanism may facilitate a bit map corresponding to a definition, signaling, indication, and/or negotiation of an allocation of TWT periods, for example, restricted TWTs and/o any other TWT periods, e.g., as described below.

[00347] Reference is made to Fig. 10, which schematically illustrates a TWT allocation, in accordance with some demonstrative embodiments. For example, controller 124 (Fig. 1) may be configured to cause the EHT STA implemented by device 102 (Fig. 1), and/or controller 154 (Fig. 1) may be configured to cause the EHT STA implemented by device 140 (Fig. 1), generate, transmit, receive and/or process one or more TWT elements according to the TWT allocation of Fig. 10, and/or to communicate one or more communications during TWT defined according to the TWT allocation of Fig. 10.

[00348] In some demonstrative embodiments, a TWT element may be configured to include a bitmap corresponding to TWT periods of the TWT allocation of Fig. 10.

[00349] In some demonstrative embodiments, the bitmap may correspond to an allocation of restricted TWTs, e.g., according to the TWT allocation of Fig. 10.

[00350] In some demonstrative embodiments, a broadcast TWT, e.g., which may be broadcasted by an AP, may include a TWT element with a bitmap corresponding to the TWT allocation of Fig. 10, for example, to specify service periods during which restrictions for associated STAs may be defined.

[00351] In some demonstrative embodiments, a TWT element may utilize a bitmap defined with respect to multiple slots/service periods. For example, the multiple slots/service periods may be defined according to the TWT allocation of Fig. 10, e.g., as described below.

[00352] In some demonstrative embodiments, a slot, e.g., each slot, may have a Broadcast (BCST) TWT Identifier (ID) that starts at 1 and increments each slot, e.g., as shown in Fig. 10.

[00353] In some demonstrative embodiments, a plurality of service periods defined according to the TWT allocation, e.g., each of the service periods, may have one or more common parameters and/or attributes, e.g., as described below.

[00354] In some demonstrative embodiments, a plurality of service periods defined according to the TWT allocation, e.g., each of the service periods, may have the same SP duration, and/or the same periodicity. For example, the periodicity may correspond to the number of slots/SPs in the bitmap size multiplied by the SP duration.

[00355] In other embodiments, any other definition may be used for the plurality of service periods according to the TWT allocation.

[00356] In some demonstrative embodiments, a TWT element corresponding to a TWT allocation of TWT periods may be configured to signal the definition of the TWT periods according to the TWT allocation, e.g., as described below.

[00357] For example, a TWT element including a bitmap corresponding to the TWT allocation of Fig. 10 may be configured to signal the TWT periods of the TWT allocation of Fig. 10.

[00358] In some demonstrative embodiments, a broadcast TWT may be configured to signal a TWT allocation of TWT periods, e.g., according to the TWT allocation of Fig. 10, for example, by sending a broadcast TWT element for a first slot, e.g., with ID1.

[00359] In some demonstrative embodiments, one or more fields of the TWT element may be defined and/or set to signal the allocation of the TWT periods according to the TWT allocation, e.g., as described below.

[00360] In some demonstrative embodiments, a reserved bit in the TWT element, or a new field, may be set to a predefined value, e.g., 1, to indicate that this TWT element describes the first SP/slot of a bitmap of back-to-back SPs/slots.

[00361] In some demonstrative embodiments, an SP duration, e.g., a Nominal Minimum TWT Wake Duration field in the TWT element, may be set to be the duration of all the SPs/slots in the bitmap.

[00362] In some demonstrative embodiments, an SP periodicity, e.g., as defined by a TWT Wake Interval Mantissa and/or a TWT Wake Interval Exponent in the TWT element, may be set to be the duration of the bitmap, e.g., a number of slots in the bitmap multiplied by the SP duration.

[00363] In some demonstrative embodiments, the TWT, e.g., a TWT field, may be set to the start of an immediately following BC TWT ID1.

[00364] In some demonstrative embodiments, implementing the above settings of the fields of the TWT element may enable a STA receiving the TWT element, e.g., a STA implemented by device 102 (Fig. 1), to determine a start time (TWT start) of each BC TWT ID, for example, by the following equation:

TWT for TWTID2 = TWT for TWTID1 + SP duration,

TWT for TWTID3 = TWT for TWTID1 + 2*SP duration;

and so on, e.g.,:

TWT for TWTID(Y) = TWT for TWTID1 + (Y-1)*SP duration.

[00365] In some demonstrative embodiments, a TWT element, e.g., a BC TWT element, may include a bitmap, e.g., added to the broadcast TWT element.

[00366] In some demonstrative embodiments, a size of the bitmap may be explicitly signaled in the TWT element. In other embodiments, the size of the bitmap may be derived, e.g., by the equation:

Bitmap size = TWT periodicity/SPduration.

[00367] In one example, a TWT allocation may include 10 slots, for example, each SP may be 1 millisecond (ms) long, and the SP periodicity may be 10ms. According to this example, a 10 bit bitmap may be used. For example, each bit in the bitmap may have the index that corresponds to the BC TWT ID, e.g., as follows:

- Index 0 corresponds to TWTID1;
- Index 1 corresponds to TWT ID2;
- ...
- Index 9 corresponds to TWT ID10.

[00368] In some demonstrative embodiments, a bit, e.g., each bit, of the bitmap may be set to indicate whether or not at least one associated STA is a member of the BC TWT ID that corresponds to this bit.

[00369] In some demonstrative embodiments, a bit, e.g., each bit, of the bitmap may be set to 1, for example, if at least one associated STA is a member of the BC TWT ID that corresponds to this bit.

[00370] In some demonstrative embodiments, the bit, e.g., each bit, of the bitmap may be set to 0, e.g., otherwise.

[00371] In some demonstrative embodiments, an EHT associated STA, e.g., a STA implemented by device 102 (Fig. 1), that receives the TWT element shall ensure it respects the rules related to restricted TWTs, for example, for each of the BC TWT IDs whose bit in the bitmap is set to 1. For example, the EHT associated STA shall end its TxOP before the start of the TWT SP for that BC TWT ID.

[00372] In some demonstrative embodiments, a plurality of EHT STAs, the EHT STAs implemented by device 102 (Fig. 1) and/or device 140 (Fig. 1), may utilize the TWT element and/or bitmap for TWT negotiation, for example, so that a STA can become a member of a particular BC TWT ID, e.g., as described below.

[00373] In some demonstrative embodiments, when a STA, e.g., the EHT STA implemented by device 102 (Fig. 1) and/or the EHT STA implemented by device 140 (Fig. 1), negotiates a TWT agreement, the STA may request a list of TWT IDs, e.g., as described below.

[00374] In one example, the STA may request the TWT ID4 only.

[00375] In another example, the STA may request the TWT ID4 and ID5.

[00376] In another example, the STA may request the TWT ID2, ID4, ID6, ID8, ID10, ID12, ID14, ID16, ID18, ID20>>> basically an TWT ID every 2 IDs.

[00377] In some demonstrative embodiments, when a STA, e.g., the EHT STA implemented by device 102 (Fig. 1) and/or the EHT STA implemented by device 140 (Fig. 1), negotiates a TWT agreement, the STA may request one or multiple consecutive TWT IDs, and a periodicity in number of TWTID slots, e.g., as described below.

[00378] In one example, the SAT may request the TWT ID4 only.

[00379] In another example, the STA may request the TWT ID4 and ID5.

[00380] In another example, the STA may request the TWT ID2 and a periodicity of 2IDs to capture a request for ID2,4,6,8,10,12,14,16,18,20.

[00381] In some demonstrative embodiments, a STA, e.g., the EHT STA implemented by device 102 (Fig. 1) and/or the EHT STA implemented by device 140 (Fig. 1), may negotiate a TWT agreement, for example, by including in a request TWT element the TWT, SP duration and SP periodicity values, e.g., in existing fields, while making sure that these values match the start time of a BC TWT ID, and a multiple of the SP duration of BC TWT IDs and periodicity in multiple of the BC TWT ID SP duration.

[00382] In some demonstrative embodiments, an AP, e.g., the EHT AP STA implemented by device 140 (Fig. 1), may respond to the request TWT element, for example, by making the STA join the BCST TWT IDs, e.g., as described below.

[00383] In some demonstrative embodiments, the AP may list the IDs, or assign a first ID plus a periodicity in number of slot IDs.

[00384] In some demonstrative embodiments, the AP may define this TWT allocation with one or more current fields, for example, while making sure that they match the structure defined above.

[00385] In one example, a TWT allocation may defined according to a 1ms SP duration, and a 20ms periodicity. According to this example, there may be 20 slots in the bitmap structure, and the BC TWT ID may start at 1 and end at 20.

[00386] For example, if a STA1, e.g., the EHT STA implemented by device 102 (Fig. 1), wants to negotiate restricted TWTs using these BC TWT IDs, and the STA1 has traffic with a periodicity of 20ms, then the STA1 may request to participate for instance in the following TWTs:

- In all BC TWT ID 4 (there will be one BC TWT ID 4 every 20ms for 1ms);
- In all BC TWT ID 4 and 5 (periodicity of 20ms and a SP duration of 2ms);
- In BC TWT ID 2, ID4, ID6, ID8, ID10, ID12, ID14, ID16, ID18, ID20 (to have a periodicity of 2ms for a SP duration of 1ms); or
- a different allocation of TWTs matching the above requirements.

[00387] Reference is made to Fig. 11, which schematically illustrates a method of time allocation within a TxOP, in accordance with some demonstrative embodiments. For example, one or more of the operations of the method of Fig. 11 may be performed by one or more elements of a system, e.g., system 100 (Fig. 1), for example, one or more wireless devices, e.g., device 102 (Fig. 1), and/or device 140 (Fig. 1), a controller, e.g., controller 124 (Fig. 1) and/or controller 154 (Fig. 1), a radio, e.g., radio 114 (Fig. 1) and/or radio 144 (Fig. 1), and/or a message processor, e.g., message processor 128 (Fig. 1) and/or message processor 158 (Fig. 1).

[00388] As indicated at block 1102, the method may include configuring at an AP a trigger frame to include one user information (info) field addressed to a single non-AP STA. For example, controller 154 (Fig. 1) may be configured to cause, trigger, and/or control device 140 (Fig. 1) to configure a trigger frame to include one user info field addressed to a single non-AP STA, for example, the non-AP STA implemented by device 102 (Fig. 1), e.g., as described above.

[00389] As indicated at block 1104, the method may include setting a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a TxOP of the AP, the allocated time configured for transmission of one or more PPDUs from the non-AP STA. For example, controller 154 (Fig. 1) may be configured to cause, trigger, and/or control device 140 (Fig. 1) to

set the common info field of the trigger frame to indicate that the trigger frame is to allocate the allocated time for the non-AP STA within the TxOP of the AP, e.g., as described above.

[00390] As indicated at block 1106, the method may include transmitting the trigger frame to initiate the allocation of the allocated time to the non-AP STA. For example, controller 154 (Fig. 1) may be configured to cause, trigger, and/or control device 140 (Fig. 1) to transmit the trigger frame to initiate the allocation of the allocated time to the non-AP STA, e.g., as described above.

[00391] Reference is made to Fig. 12, which schematically illustrates a method of time allocation within a TxOP, in accordance with some demonstrative embodiments. For example, one or more of the operations of the method of Fig. 12 may be performed by one or more elements of a system, e.g., system 100 (Fig. 1), for example, one or more wireless devices, e.g., device 102 (Fig. 1), and/or device 140 (Fig. 1), a controller, e.g., controller 124 (Fig. 1) and/or controller 154 (Fig. 1), a radio, e.g., radio 114 (Fig. 1) and/or radio 144 (Fig. 1), and/or a message processor, e.g., message processor 128 (Fig. 1) and/or message processor 158 (Fig. 1).

[00392] As indicated at block 1202, the method may include processing at a non-AP STA a trigger frame from an AP to identify that the trigger frame includes one user information (info) field addressed to the non-AP STA. For example, controller 124 (Fig. 1) may be configured to cause, trigger, and/or control device 102 (Fig. 1) to process the trigger frame from device 140 (Fig. 1), e.g., as described above.

[00393] As indicated at block 1204, the method may include identifying based on a common info field of the trigger frame that the trigger frame is to allocate an allocated time for the non-AP STA within a TxOP of the AP. For example, controller 124 (Fig. 1) may be configured to cause, trigger, and/or control device 102 (Fig. 1) to identify, based on a common info field of the trigger frame, that the trigger frame is to allocate an allocated time for the non-AP STA within the TxOP of the AP, e.g., as described above.

[00394] As indicated at block 1206, the method may include transmitting one or more PPDUs from the non-AP STA during the allocated time for the non-AP STA. For example, controller 124 (Fig. 1) may be configured to cause, trigger, and/or control

device 102 (Fig. 1) to transmit one or more PPDUs from the non-AP STA during the allocated time for the non-AP STA, e.g., as described above.

[00395] Reference is made to Fig. 13, which schematically illustrates a method of communication based on a TWT allocation, in accordance with some demonstrative embodiments. For example, one or more of the operations of the method of Fig. 13 may be performed by one or more elements of a system, e.g., system 100 (Fig. 1), for example, one or more wireless devices, e.g., device 102 (Fig. 1), and/or device 140 (Fig. 1), a controller, e.g., controller 124 (Fig. 1) and/or controller 154 (Fig. 1), a radio, e.g., radio 114 (Fig. 1) and/or radio 144 (Fig. 1), and/or a message processor, e.g., message processor 128 (Fig. 1) and/or message processor 158 (Fig. 1).

[00396] As indicated at block 1302, the method may include configuring at an EHT STA a bitmap including a plurality of bits corresponding to a respective plurality of TWT periods, wherein a bit in the bitmap corresponding to a TWT period is set to 1 to indicate that there is at least one STA associated with the TWT period. For example, controller 154 (Fig. 1) may be configured to cause, trigger, and/or control device 140 (Fig. 1) to configure the bitmap including the plurality of bits corresponding to the respective plurality of TWT periods, e.g., as described above.

[00397] As indicated at block 1304, the method may include transmitting a Broadcast (BC) TWT element including the bitmap. For example, controller 154 (Fig. 1) may be configured to cause, trigger, and/or control device 140 (Fig. 1) to transmit the BC TWT element including the bitmap, e.g., as described above.

[00398] Reference is made to Fig. 14, which schematically illustrates a method of communication based on a TWT allocation, in accordance with some demonstrative embodiments. For example, one or more of the operations of the method of Fig. 14 may be performed by one or more elements of a system, e.g., system 100 (Fig. 1), for example, one or more wireless devices, e.g., device 102 (Fig. 1), and/or device 140 (Fig. 1), a controller, e.g., controller 124 (Fig. 1) and/or controller 154 (Fig. 1), a radio, e.g., radio 114 (Fig. 1) and/or radio 144 (Fig. 1), and/or a message processor, e.g., message processor 128 (Fig. 1) and/or message processor 158 (Fig. 1).

[00399] As indicated at block 1402, the method may include processing at an EHT STA a bitmap in a received BC TWT element, the bitmap including a plurality of bits

corresponding to a respective plurality of TWT periods. For example, controller 124 (Fig. 1) may be configured to cause, trigger, and/or control device 102 (Fig. 1) to process a bitmap in a received BC TWT element from device 140 (Fig. 1), e.g., as described above.

[00400] As indicated at block 1404, the method may include identifying that there is at least one STA associated with the TWT period, for example, based on a determination that a bit in the bitmap corresponding to a TWT period is set to 1. For example, controller 124 (Fig. 1) may be configured to cause, trigger, and/or control device 102 (Fig. 1) to, based on a determination that a bit in the bitmap corresponding to a TWT period is set to 1, identify that there is at least one STA associated with the TWT period, e.g., as described above.

[00401] Reference is made to Fig. 15, which schematically illustrates a product of manufacture 1500, in accordance with some demonstrative embodiments. Product 1500 may include one or more tangible computer-readable ("machine-readable") non-transitory storage media 1502, which may include computer-executable instructions, e.g., implemented by logic 1504, operable to, when executed by at least one computer processor, enable the at least one computer processor to implement one or more operations at device 102 (Fig. 1), device 140 (Fig. 1), controller 124 (Fig. 1), controller 154 (Fig. 1), message processor 128 (Fig. 1), message processor 158 (Fig. 1), radio 114 (Fig. 1), radio 144 (Fig. 1), transmitter 118 (Fig. 1), transmitter 148 (Fig. 1), receiver 116 (Fig. 1), and/or receiver 146 (Fig. 1); to cause device 102 (Fig. 1), device 140 (Fig. 1), controller 124 (Fig. 1), controller 154 (Fig. 1), message processor 128 (Fig. 1), message processor 158 (Fig. 1), radio 114 (Fig. 1), radio 144 (Fig. 1), transmitter 118 (Fig. 1), transmitter 148 (Fig. 1), receiver 116 (Fig. 1), and/or receiver 146 (Fig. 1) to perform, trigger and/or implement one or more operations and/or functionalities; and/or to perform, trigger and/or implement one or more operations and/or functionalities described with reference to the Figs. 1-14, and/or one or more operations described herein. The phrases "non-transitory machine-readable medium" and "computer-readable non-transitory storage media" may be directed to include all machine and/or computer readable media, with the sole exception being a transitory propagating signal.

[00402] In some demonstrative embodiments, product 1500 and/or machine readable storage media 1502 may include one or more types of computer-readable storage media

capable of storing data, including volatile memory, non-volatile memory, removable or non-removable memory, erasable or non-erasable memory, writeable or re-writeable memory, and the like. For example, machine readable storage media 1502 may include, RAM, DRAM, Double-Data-Rate DRAM (DDR-DRAM), SDRAM, static RAM (SRAM), ROM, programmable ROM (PROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), flash memory (e.g., NOR or NAND flash memory), content addressable memory (CAM), polymer memory, phase-change memory, ferroelectric memory, silicon-oxide-nitride-oxide-silicon (SONOS) memory, a hard drive, an optical disk, a magnetic disk, and the like. The computer-readable storage media may include any suitable media involved with downloading or transferring a computer program from a remote computer to a requesting computer carried by data signals embodied in a carrier wave or other propagation medium through a communication link, e.g., a modem, radio or network connection.

[00403] In some demonstrative embodiments, logic 1504 may include instructions, data, and/or code, which, if executed by a machine, may cause the machine to perform a method, process and/or operations as described herein. The machine may include, for example, any suitable processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, or the like, and may be implemented using any suitable combination of hardware, software, firmware, and the like.

[00404] In some demonstrative embodiments, logic 1504 may include, or may be implemented as, software, a software module, an application, a program, a subroutine, instructions, an instruction set, computing code, words, values, symbols, and the like. The instructions may include any suitable type of code, such as source code, compiled code, interpreted code, executable code, static code, dynamic code, and the like. The instructions may be implemented according to a predefined computer language, manner or syntax, for instructing a processor to perform a certain function. The instructions may be implemented using any suitable high-level, low-level, object-oriented, visual, compiled and/or interpreted programming language, such as C, C++, Java, BASIC, Matlab, Pascal, Visual BASIC, assembly language, machine code, and the like.

EXAMPLES

[00405] The following examples pertain to further embodiments.

[00406] Example 1 includes an apparatus comprising logic and circuitry configured to cause an Access Point (AP) to configure a trigger frame to include one user information (info) field addressed to a single non-AP wireless communication station (STA); set a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP, the allocated time configured for transmission of one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA; and transmit the trigger frame to initiate the allocation of the allocated time to the non-AP STA.

[00407] Example 2 includes the subject matter of Example 1, and optionally, wherein the allocated time is configured for sequential transmission of PPDUs from the non-AP STA.

[00408] Example 3 includes the subject matter of Example 1 or 2, and optionally, wherein the one or more PPDUs are non-Trigger-based (non-TB) PPDUs.

[00409] Example 4 includes the subject matter of any one of Examples 1-3, and optionally, wherein the apparatus is configured to cause the AP to set a mode field in the common info field to indicate a type of the allocation of the allocated time for the non-AP STA.

[00410] Example 5 includes the subject matter of Example 4, and optionally, wherein the apparatus is configured to cause the AP to set the mode field to a predefined mode value from a plurality of predefined mode values, the plurality of predefined mode values to indicate a respective plurality of allocation modes.

[00411] Example 6 includes the subject matter of Example 5, and optionally, wherein the plurality of predefined mode values comprises three mode values to indicate three respective allocation modes.

[00412] Example 7 includes the subject matter of Example 5 or 6, and optionally, wherein the plurality of predefined mode values comprises a first mode value and a second mode value, the first mode value to indicate an Uplink (UL) mode, in which the

non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, the second mode value to indicate a Peer-to Peer (P2P) mode, in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

[00413] Example 8 includes the subject matter of any one of Examples 1-7, and optionally, wherein the apparatus is configured to cause the AP to set a mode field in the common info field to indicate an Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA.

[00414] Example 9 includes the subject matter of any one of Examples 1-7, and optionally, wherein the apparatus is configured to cause the AP to set the mode field in the common info field to indicate a Peer-to-Peer (P2P) mode, in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

[00415] Example 10 includes the subject matter of any one of Examples 1-9, and optionally, wherein the apparatus is configured to cause the AP to process a response from the non-AP STA in response to the trigger frame.

[00416] Example 11 includes the subject matter of any one of Examples 1-10, and optionally, wherein the apparatus is configured to cause the AP to set a field in the trigger frame to indicate a length of the allocated time.

[00417] Example 12 includes the subject matter of any one of Examples 1-11, and optionally, wherein the apparatus is configured to cause the AP to transmit a Block Acknowledgement (BA) to the non-AP STA based on a PPDU received from the non-AP STA during the allocated time.

[00418] Example 13 includes the subject matter of any one of Examples 1-12, and optionally, wherein the apparatus is configured to enable the AP to transmit a frame a predefined Inter-Frame-Space (IFS) after a PPDU from the non-AP STA during the allocated time.

[00419] Example 14 includes the subject matter of any one of Examples 1-13, and optionally, wherein the trigger frame comprises a control frame.

[00420] Example 15 includes the subject matter of any one of Examples 1-14, and optionally, wherein the apparatus is configured to allow the AP to perform a transmission before an end of the allocated time for the non-AP STA.

[00421] Example 16 includes the subject matter of any one of Examples 1-15, and optionally, wherein the apparatus is configured to cause the AP to perform a transmission before an end of the allocated time for the non-AP STA based on a Point-Inter-Frame-Space (PIFS) idle rule.

[00422] Example 17 includes the subject matter of any one of Examples 1-16, and optionally, wherein the AP is an Extremely High Throughput (EHT) AP.

[00423] Example 18 includes the subject matter of any one of Examples 1-17, and optionally, comprising a radio to transmit the trigger frame.

[00424] Example 19 includes the subject matter of Example 18, and optionally, comprising one or more antennas connected to the radio, and a processor to execute instructions of an operating system of the AP.

[00425] Example 20 includes an apparatus comprising logic and circuitry configured to cause a non Access Point (AP) (non-AP) wireless communication station (STA) to process a trigger frame from an AP to identify that the trigger frame comprises one user information (info) field addressed to the non-AP STA; identify based on a common info field of the trigger frame that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP; and transmit one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA during the allocated time for the non-AP STA.

[00426] Example 21 includes the subject matter of Example 20, and optionally, wherein the apparatus is configured to allow the non-AP STA to perform sequential transmission of PPDUs during the allocated time for the non-AP STA.

[00427] Example 22 includes the subject matter of Example 20 or 21, and optionally, wherein the one or more PPDUs are non-Trigger-based (non-TB) PPDUs.

[00428] Example 23 includes the subject matter of any one of Examples 20-22, and optionally, wherein the apparatus is configured to cause the non-AP STA to transmit a response to the AP in response to the trigger frame.

[00429] Example 24 includes the subject matter of any one of Examples 20-23, and optionally, wherein the apparatus is configured to cause the non-AP STA to process a mode field in the trigger frame, and to determine a type of the allocation of the allocated time for the non-AP STA based on the mode field.

[00430] Example 25 includes the subject matter of Example 24, and optionally, wherein the apparatus is configured to cause the non-AP to determine the type of the allocation of the allocated time for the non-AP STA based on a determination that the mode field comprises a mode value from a plurality of predefined mode values, the plurality of predefined mode values to indicate a respective plurality of allocation modes.

[00431] Example 26 includes the subject matter of Example 25, and optionally, wherein the plurality of predefined mode values comprises three mode values to indicate three respective allocation modes.

[00432] Example 27 includes the subject matter of Example 25 or 26, and optionally, wherein the plurality of predefined mode values comprises a first mode value and a second mode value, the first mode value to indicate an Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, the second mode value to indicate a Peer-to-Peer (P2P) mode, in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

[00433] Example 28 includes the subject matter of any one of Examples 20-27, and optionally, wherein the apparatus is configured to cause the non-AP STA to, based on a determination that a mode field in the common info field indicates an Uplink (UL) mode, allow the non-AP STA to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA.

[00434] Example 29 includes the subject matter of any one of Examples 20-27, and optionally, wherein the apparatus is configured to cause the non-AP STA to, based on a determination that a mode field in the common info field indicates a Peer-to-Peer (P2P) mode, allow the non-AP STA to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

[00435] Example 30 includes the subject matter of any one of Examples 20-29, and optionally, wherein the apparatus is configured to cause the non-AP STA to identify a length of the allocated time based on a field in the trigger frame.

[00436] Example 31 includes the subject matter of any one of Examples 20-30, and optionally, wherein the apparatus is configured to cause the non-AP STA to process a Block Acknowledgement (BA) based on a PPDU transmitted from the non-AP STA during the allocated time.

[00437] Example 32 includes the subject matter of any one of Examples 20-31, and optionally, wherein the trigger frame comprises a control frame.

[00438] Example 33 includes the subject matter of any one of Examples 20-32, and optionally, wherein the non-AP STA is an Extremely High Throughput (EHT) non-AP STA.

[00439] Example 34 includes the subject matter of any one of Examples 20-33, and optionally, comprising a radio to communicate the trigger frame and the one or more PPDUs.

[00440] Example 35 includes the subject matter of Example 34, and optionally, comprising one or more antennas connected to the radio, and a processor to execute instructions of an operating system of the non-AP STA.

[00441] Example 36 includes an apparatus comprising logic and circuitry configured to cause an Extremely High Throughput (EHT) wireless communication station (STA) to configure a bitmap comprising a plurality of bits corresponding to a respective plurality of Target Wake Time (TWT) periods, wherein a bit in the bitmap corresponding to a TWT period is set to 1 to indicate that there is at least one STA associated with the TWT period; and transmit a Broadcast (BC) TWT element comprising the bitmap.

[00442] Example 37 includes the subject matter of Example 36, and optionally, wherein the apparatus is configured to cause the EHT STA to set a field in the BC TWT element to indicate that information in one more fields of the BC TWT element relates to a first-in-order TWT period of the plurality of TWT periods.

[00443] Example 38 includes the subject matter of Example 37, and optionally, wherein the field in the BC TWT element comprises a one-bit field.

[00444] Example 39 includes the subject matter of any one of Examples 36-38, and optionally, wherein the apparatus is configured to cause the EHT STA to set a duration field in the BC TWT element to indicate a duration of all of the plurality of TWT periods.

[00445] Example 40 includes the subject matter of any one of Examples 36-39, and optionally, wherein the apparatus is configured to cause the EHT STA to set a TWT interval field in the BC TWT element to indicate a Service Period (SP) periodicity corresponding to the plurality of TWT periods.

[00446] Example 41 includes the subject matter of any one of Examples 36-40, and optionally, wherein the apparatus is configured to cause the EHT STA to set a TWT field in the BC TWT element to indicate a beginning of a first-in-order TWT period of the plurality of TWT periods.

[00447] Example 42 includes the subject matter of any one of Examples 36-41, and optionally, wherein another bit in the bitmap corresponding to an other TWT period is set to 0 to indicate that there is no STA associated with the other TWT period.

[00448] Example 43 includes the subject matter of any one of Examples 36-42, and optionally, comprising a radio to transmit the BC TWT element.

[00449] Example 44 includes the subject matter of Example 43, and optionally, comprising one or more antennas connected to the radio, and a processor to execute instructions of an operating system of the EHT STA.

[00450] Example 45 includes an apparatus comprising logic and circuitry configured to cause an Extremely High Throughput (EHT) wireless communication station (STA) to process a bitmap in a received Broadcast (BC) Target Wake Time (TWT) element, the bitmap comprising a plurality of bits corresponding to a respective plurality of TWT periods; and based on a determination that a bit in the bitmap corresponding to a TWT period is set to 1, identify that there is at least one STA associated with the TWT period.

[00451] Example 46 includes the subject matter of Example 45, and optionally, wherein the apparatus is configured to cause the EHT STA to, based on a field in the BC TWT element, process information in one more fields of the BC TWT element with relation to a first-in-order TWT period of the plurality of TWT periods.

[00452] Example 47 includes the subject matter of Example 46, and optionally, wherein the field in the BC TWT element comprises a one-bit field.

[00453] Example 48 includes the subject matter of any one of Examples 45-47, and optionally, wherein the apparatus is configured to cause the EHT STA to determine a duration of all of the plurality of TWT periods based on a duration field in the BC TWT element.

[00454] Example 49 includes the subject matter of any one of Examples 45-48, and optionally, wherein the apparatus is configured to cause the EHT STA to determine a Service Period (SP) periodicity corresponding to the plurality of TWT periods based on a TWT interval field in the BC TWT element.

[00455] Example 50 includes the subject matter of any one of Examples 45-49, and optionally, wherein the apparatus is configured to cause the EHT STA to determine a beginning of a first-in-order TWT period of the plurality of TWT periods based on a TWT field in the BC TWT element.

[00456] Example 51 includes the subject matter of any one of Examples 45-50, and optionally, wherein the apparatus is configured to cause the EHT STA to, based on a determination that another bit in the bitmap corresponding to an other TWT period is set to 0, determine that there is no STA associated with the other TWT period.

[00457] Example 52 includes the subject matter of any one of Examples 45-51, and optionally, comprising a radio to receive the BC TWT element.

[00458] Example 53 includes the subject matter of Example 52, and optionally, comprising one or more antennas connected to the radio, and a processor to execute instructions of an operating system of the EHT STA.

[00459] Example 54 comprises an apparatus comprising means for executing any of the described operations of Examples 1-53.

[00460] Example 55 comprises a product comprising one or more tangible computer-readable non-transitory storage media comprising computer-executable instructions operable to, when executed by at least one processor, enable the at least one processor to cause a computing device to perform any of the described operations of Examples 1-53.

[00461] Example 56 comprises an apparatus comprising: a memory interface; and processing circuitry configured to: perform any of the described operations of Examples 1-53.

[00462] Example 57 comprises a method comprising any of the described operations of Examples 1-53.

[00463] Functions, operations, components and/or features described herein with reference to one or more aspects, may be combined with, or may be utilized in combination with, one or more other functions, operations, components and/or features described herein with reference to one or more other aspects, or vice versa.

[00464] While certain features have been illustrated and described herein, many modifications, substitutions, changes, and equivalents may occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the disclosure.

CLAIMS

What is claimed is:

1. An apparatus comprising logic and circuitry configured to cause an Access Point (AP) to:

configure a trigger frame to include one user information (info) field addressed to a single non-AP wireless communication station (STA);

set a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP, the allocated time configured for transmission of one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA; and

transmit the trigger frame to initiate the allocation of the allocated time to the non-AP STA.

2. The apparatus of claim 1 configured to cause the AP to set a mode field in the common info field to indicate a type of the allocation of the allocated time for the non-AP STA.

3. The apparatus of claim 2 configured to cause the AP to set the mode field to a predefined mode value from a plurality of predefined mode values, the plurality of predefined mode values to indicate a respective plurality of allocation modes.

4. The apparatus of claim 3, wherein the plurality of predefined mode values comprises three mode values to indicate three respective allocation modes.

5. The apparatus of claim 3, wherein the plurality of predefined mode values comprises a first mode value and a second mode value, the first mode value to indicate an Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, the second mode value to indicate a Peer-to Peer (P2P) mode, in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

6. The apparatus of claim 1 configured to cause the AP to set a mode field in the common info field to indicate an Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA.

7. The apparatus of claim 1 configured to cause the AP to set the mode field in the common info field to indicate a Peer-to-Peer (P2P) mode, in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

8. The apparatus of claim 1 configured to cause the AP to transmit a Block Acknowledgement (BA) to the non-AP STA based on a PPDU received from the non-AP STA during the allocated time.

9. The apparatus of any one of claims 1-8 configured to enable the AP to transmit a frame a predefined Inter-Frame-Space (IFS) after a PPDU from the non-AP STA during the allocated time.

10. The apparatus of any one of claims 1-8, wherein the trigger frame comprises a control frame.

11. The apparatus of any one of claims 1-8 configured to allow the AP to perform a transmission before an end of the allocated time for the non-AP STA.

12. The apparatus of any one of claims 1-8 configured to cause the AP to perform a transmission before an end of the allocated time for the non-AP STA based on a Point-Inter-Frame-Space (PIFS) idle rule.

13. The apparatus of any one of claims 1-8, wherein the AP is an Extremely High Throughput (EHT) AP.

14. The apparatus of any one of claims 1-8 comprising a radio to transmit the trigger frame.

15. The apparatus of claim 14 comprising one or more antennas connected to the radio, and a processor to execute instructions of an operating system of the AP.

16. A product comprising one or more tangible computer-readable non-transitory storage media comprising computer-executable instructions operable to, when executed by at least one processor, enable the at least one processor to cause an Access Point (AP) to:

configure a trigger frame to include one user information (info) field addressed to a single non-AP wireless communication station (STA);

set a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP, the allocated time configured for transmission of one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA; and

transmit the trigger frame to initiate the allocation of the allocated time to the non-AP STA.

17. The product of claim 16, wherein the instructions, when executed, cause the AP to set a mode field in the common info field to indicate a type of the allocation of the allocated time for the non-AP STA.

18. The product of claim 17, wherein the instructions, when executed, cause the AP to set the mode field to a predefined mode value from a plurality of predefined mode values, the plurality of predefined mode values to indicate a respective plurality of allocation modes.

19. The product of claim 18, wherein the plurality of predefined mode values comprises three mode values to indicate three respective allocation modes.

20. The product of claim 18, wherein the plurality of predefined mode values comprises a first mode value and a second mode value, the first mode value to indicate an Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA, the second mode value to indicate a Peer-to Peer (P2P) mode, in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

21. The product of claim 16, wherein the instructions, when executed, cause the AP to set a mode field in the common info field to indicate an Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA.

22. The product of claim 16, wherein the instructions, when executed, cause the AP to set the mode field in the common info field to indicate a Peer-to-Peer (P2P) mode,

in which the non-AP STA is allowed to transmit PPDUs to other non-AP STAs during the allocated time for the non-AP STA.

23. An apparatus for an Access Point (AP), the apparatus comprising:

means for configuring a trigger frame to include one user information (info) field addressed to a single non-AP wireless communication station (STA);

means for setting a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP, the allocated time configured for transmission of one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA; and

means for causing the AP to transmit the trigger frame to initiate the allocation of the allocated time to the non-AP STA.

24. The apparatus of claim 23 comprising means for setting a mode field in the common info field to indicate a type of the allocation of the allocated time for the non-AP STA.

AMENDED CLAIMS
received by the International Bureau on 24 December 2021 (24.12.2021)

What is claimed is:

1. A method to be performed at a non Access Point (AP) (non-AP) wireless communication station (STA), the method comprising:

processing a trigger frame from an AP to identify that the trigger frame comprises one user information (info) field addressed to the non-AP STA;

identifying based on a common info field of the trigger frame that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP; and

causing the non-AP STA to transmit one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA during the allocated time for the non-AP STA.

2. The method of claim 1 comprising allowing the non-AP STA to perform sequential transmission of the PPDUs during the allocated time for the non-AP STA.

3. The method of claim 1, wherein the one or more PPDUs are non-Trigger-based (non-TB) PPDUs.

4. The method of claim 1 comprising causing the non-AP STA to transmit a response to the AP in response to the trigger frame.

5. The method of claim 1 comprising causing the non-AP STA to process a mode field in the trigger frame, and to determine a type of the allocation of the allocated time for the non-AP STA based on the mode field.

6. The method of claim 5 comprising causing the non-AP to determine the type of the allocation of the allocated time for the non-AP STA based on a determination that the mode field comprises a mode value from a plurality of predefined mode values, the plurality of predefined mode values to indicate a respective plurality of allocation modes.

7. The method of claim 6, wherein the plurality of predefined mode values comprises three mode values to indicate three respective allocation modes.

8. The method of claim 6, wherein the plurality of predefined mode values comprises a first mode value and a second mode value, the first mode value to indicate a first mode, in which the non-AP STA is allowed to transmit only Uplink (UL) PPDUs to the AP during the allocated time for the non-AP STA, the second mode value to indicate a second mode, in which the non-AP STA is allowed to transmit the one or more PPDUs to another non-AP STA during the allocated time for the non-AP STA.

9. The method of claim 1 comprising causing the non-AP STA to, based on a determination that a mode field in the common info field indicates an Uplink (UL) mode, allow the non-AP STA to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA.

10. The method of claim 1 comprising causing the non-AP STA to, based on a determination that a mode field in the common info field indicates a predefined mode, allow the non-AP STA to transmit the one or more PPDUs to another non-AP STA during the allocated time for the non-AP STA.

11. The method of claim 1 comprising causing the non-AP STA to identify a duration of the allocated time for the non-AP STA based on a field in the trigger frame.

12. The method of claim 1 comprising causing the non-AP STA to process a Block Acknowledgement (BA), the BA based on a PPDU transmitted from the non-AP STA during the allocated time for the non-AP STA.

13. The method of claim 1, wherein the non-AP STA is an Extremely High Throughput (EHT) non-AP STA.

14. A method to be performed at an Access Point (AP), the method comprising:

configuring a trigger frame to include one user information (info) field addressed to a non-AP wireless communication station (STA);

setting a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP, the allocated time configured for transmission of one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA; and

causing the AP to transmit the trigger frame to initiate the allocation of the allocated time for the non-AP STA.

15. The method of claim 14, wherein the allocated time is configured for sequential transmission of PPDUs from the non-AP STA.

16. The method of claim 14, wherein the one or more PPDUs are non-Trigger-based (non-TB) PPDUs.

17. The method of claim 14 comprising processing a response from the non-AP STA in response to the trigger frame.

18. The method of claim 14 comprising setting a mode field in the common info field to indicate a type of the allocation of the allocated time for the non-AP STA.

19. The method of claim 18 comprising setting the mode field to a mode value from a plurality of predefined mode values, the plurality of predefined mode values to indicate a respective plurality of allocation modes.

20. The method of claim 19, wherein the plurality of predefined mode values comprises three mode values to indicate three respective allocation modes.

21. The method of claim 19, wherein the plurality of predefined mode values comprises a first mode value and a second mode value, the first mode value to indicate a first mode, in which the non-AP STA is allowed to transmit only Uplink (UL) PPDUs to the AP during the allocated time for the non-AP STA, the second mode value to indicate a second mode, in which the non-AP STA is allowed to transmit the one or more PPDUs to another non-AP STA during the allocated time for the non-AP STA.

22. The method of claim 14 comprising setting a mode field in the common info field to indicate an Uplink (UL) mode, in which the non-AP STA is allowed to transmit only UL PPDUs to the AP during the allocated time for the non-AP STA.

23. The method of claim 14 comprising setting a mode field in the common info field to indicate a predefined mode, in which the non-AP STA is allowed to transmit the one or more PPDUs to another non-AP STA during the allocated time for the non-AP STA.

24. The method of claim 14 comprising setting a field in the trigger frame to indicate a length of the allocated time for the non-AP STA.

25. The method of claim 14 comprising allowing the AP to perform a transmission before an end of the allocated time for the non-AP STA.

26. The method of claim 14 comprising allowing the AP to perform a transmission before an end of the allocated time for the non-AP STA based on a Point-Inter-Frame-Space (PIFS) idle rule.

27. The method of claim 14 comprising allowing the AP to transmit a frame a predefined Inter-Frame-Space (IFS) after a PPDU from the non-AP STA during the allocated time for the non-AP STA.

28. The method of claim 14 comprising causing the AP to transmit a Block Acknowledgement (BA) to the non-AP STA based on a PPDU received from the non-AP STA during the allocated time for the non-AP STA.

29. The method of claim 14, wherein the AP is an Extremely High Throughput (EHT) AP.

30. An apparatus comprising circuitry configured to cause a wireless communication device to perform the method of any one of claims 1-29.

31. The apparatus of claim 30 comprising a radio to communicate the trigger frame.

32. The apparatus of claim 31 comprising one or more antennas connected to the radio, and a processor to execute instructions of an operating system of the wireless communication device.

33. A product comprising one or more tangible computer-readable non-transitory storage media comprising computer-executable instructions operable to, when executed by at least one processor, result in the method of any one of claims 1-29.

34. An apparatus comprising means for performing the method of any one of claims 1-29.

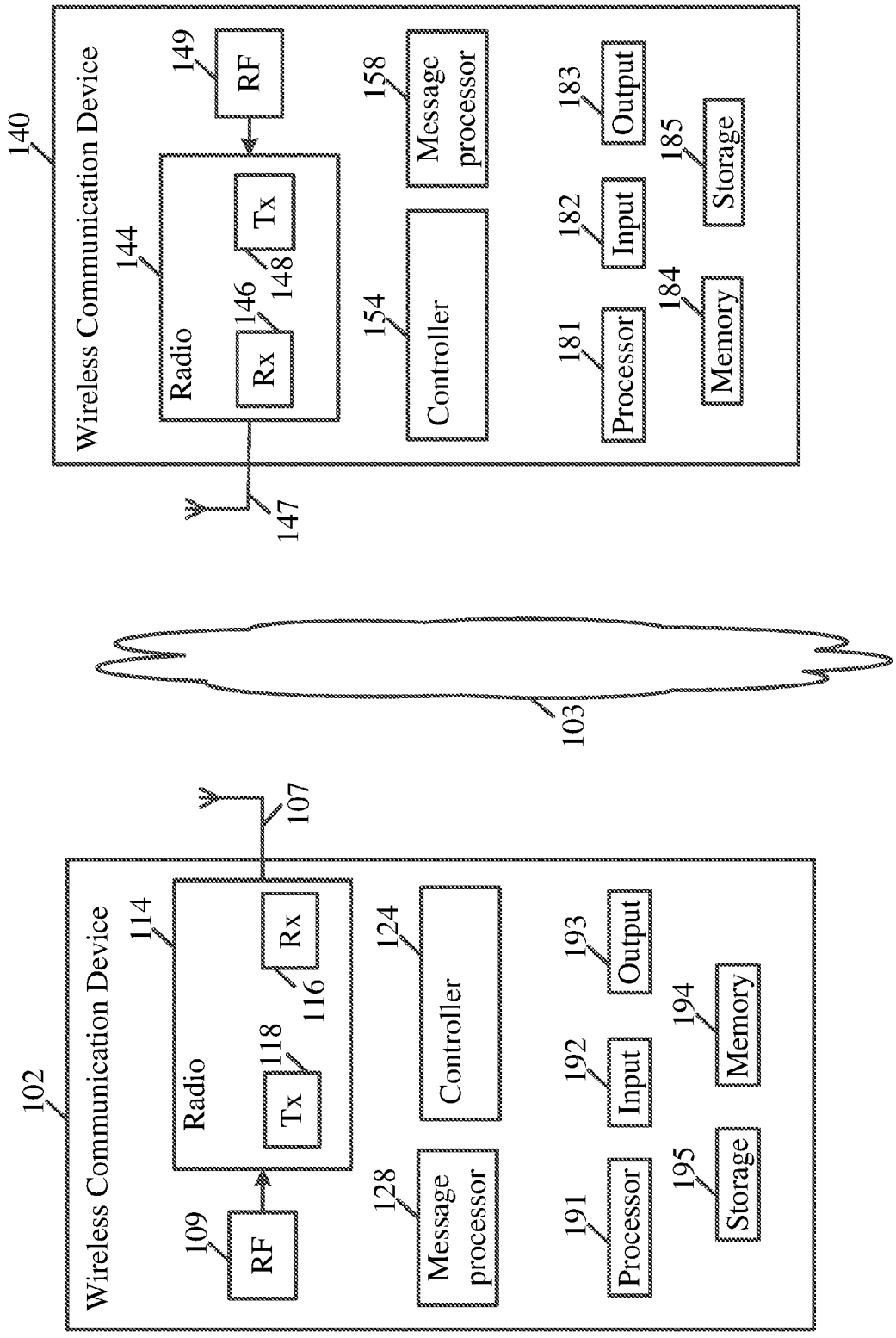
Wireless Communication Device
102
Radio
114
Tx
118
Rx
116
RF
109
107
Controller
124
Message processor
128
Processor
191
Input
192
Output
193
Memory
194
Storage
195
103
100
Wireless Communication Device
140
Radio
144
Rx
146
Tx
148
RF
149
147
Controller
154
Message processor
158
Processor
181
Input
182
Output
183
Memory
184
Storage
185

Fig. 1

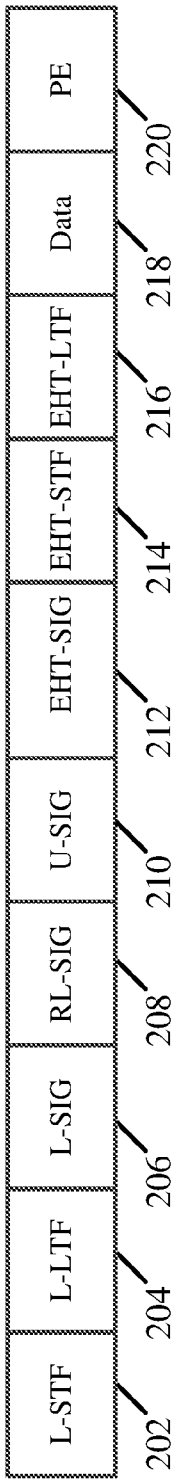
L-STF
L-LTF
L-SIG
RL-SIG
U-SIG
EHT-SIG
EHT-STF
EHT-LTF
Data
PE
202
204
206
208
210
212
214
216
218
220
200

Fig. 2

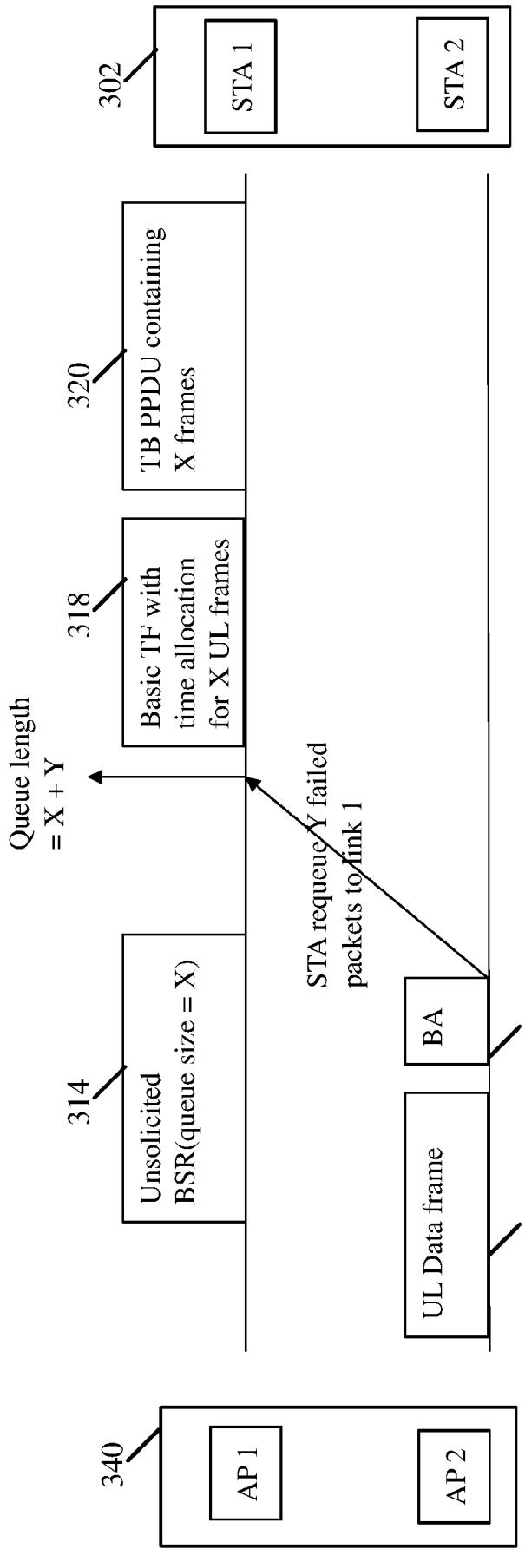
340
AP 1
AP 2
AP MLD
312
UL Data frame
316
BA
314
Unsolicited
BSR(queue size = X)
STA requeue Y failed
packets to link 1
Queue length
= X + Y
318
Basic TF with
time allocation
for X UL frames
320
TB PPDU containing
X frames
302
STA 1
STA 2

Fig. 3

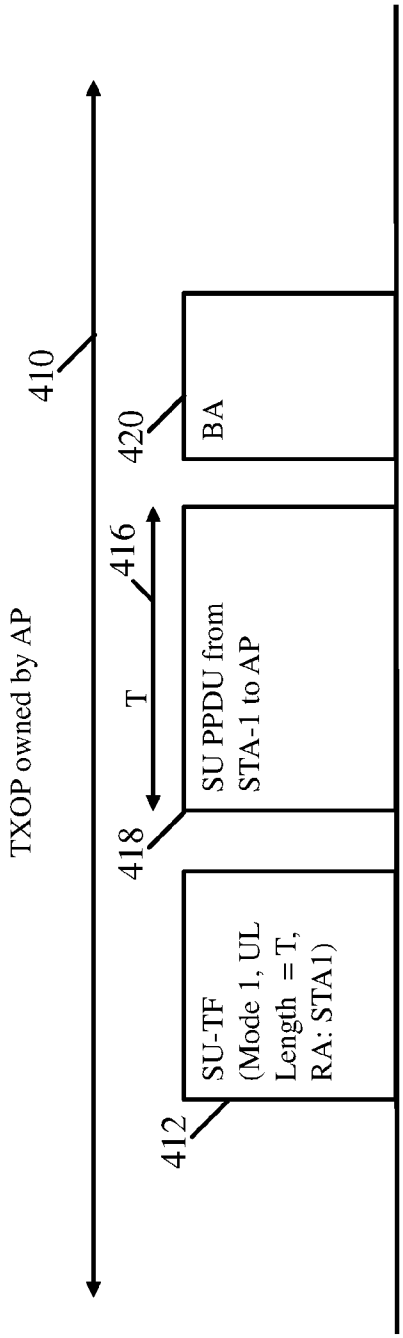
TXOP owned by AP
410
412
SU-TF
(Mode 1, UL
Length = T,
RA: STA1)
418
T
416
SU PPDU from
STA-1 to AP
420
BA

Fig. 4

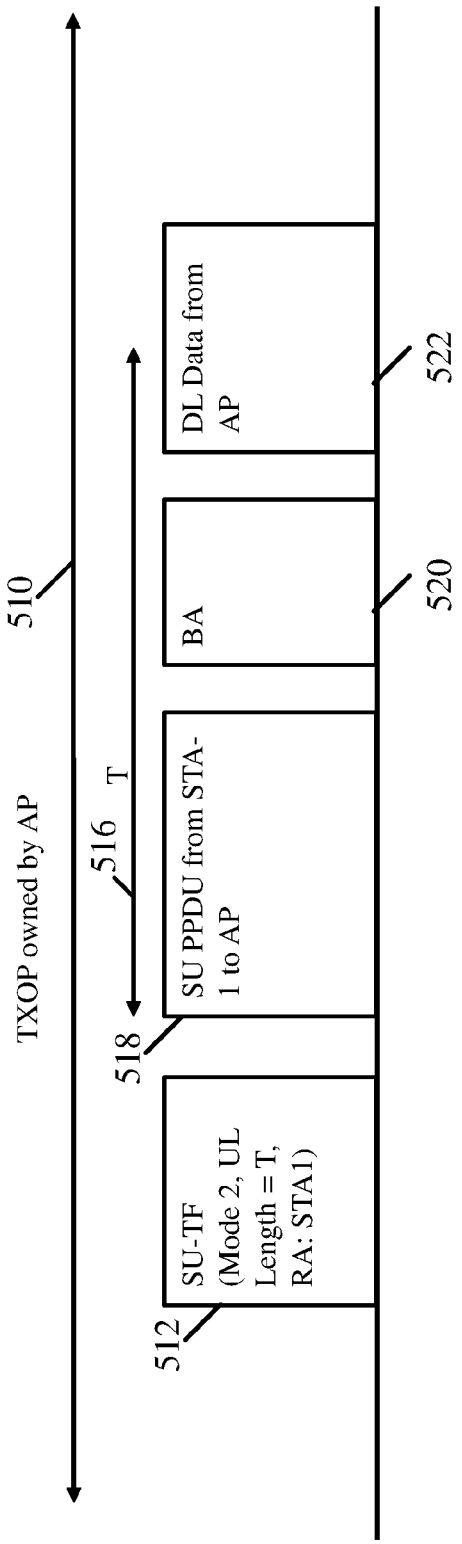
TXOP owned by AP
510
T
516
SU-TF
(Mode 2, UL
Length = T,
RA: STA1)
512
518
SU PPDU from STA-
1 to AP
BA
520
DL Data from
AP
522

Fig. 5

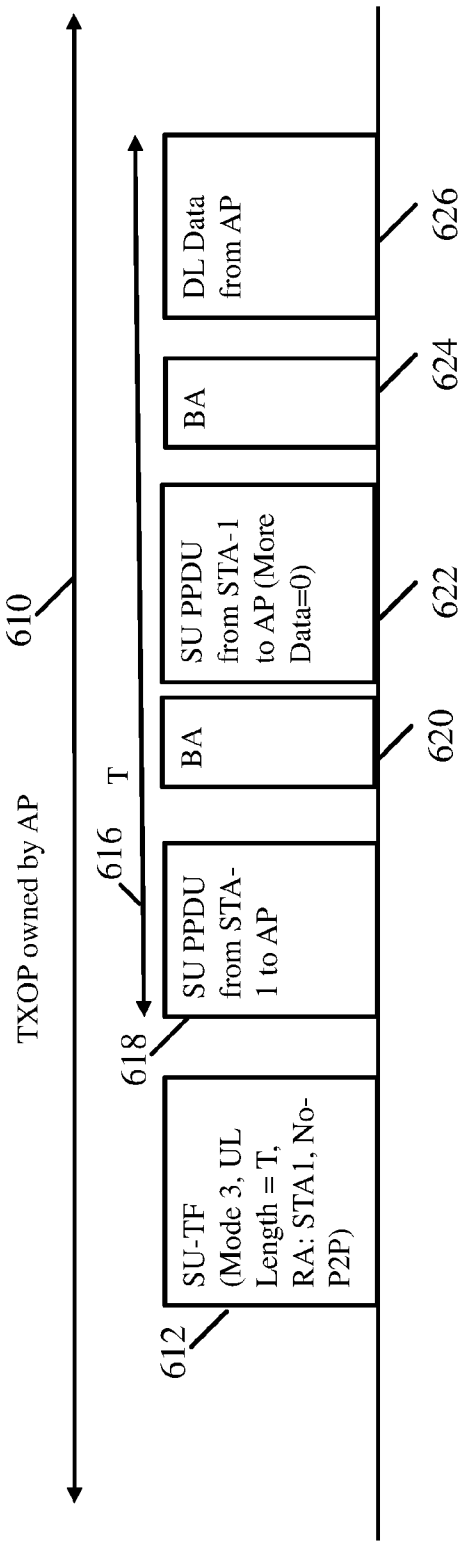
TXOP owned by AP
610
T
616
618
SU-TF (Mode 3, UL Length = T, RA: STA1, No-P2P)
612
SU PPDU from STA-1 to AP
BA
620
SU PPDU from STA-1 to AP (More Data=0)
622
BA
624
DL Data from AP
626

Fig. 6

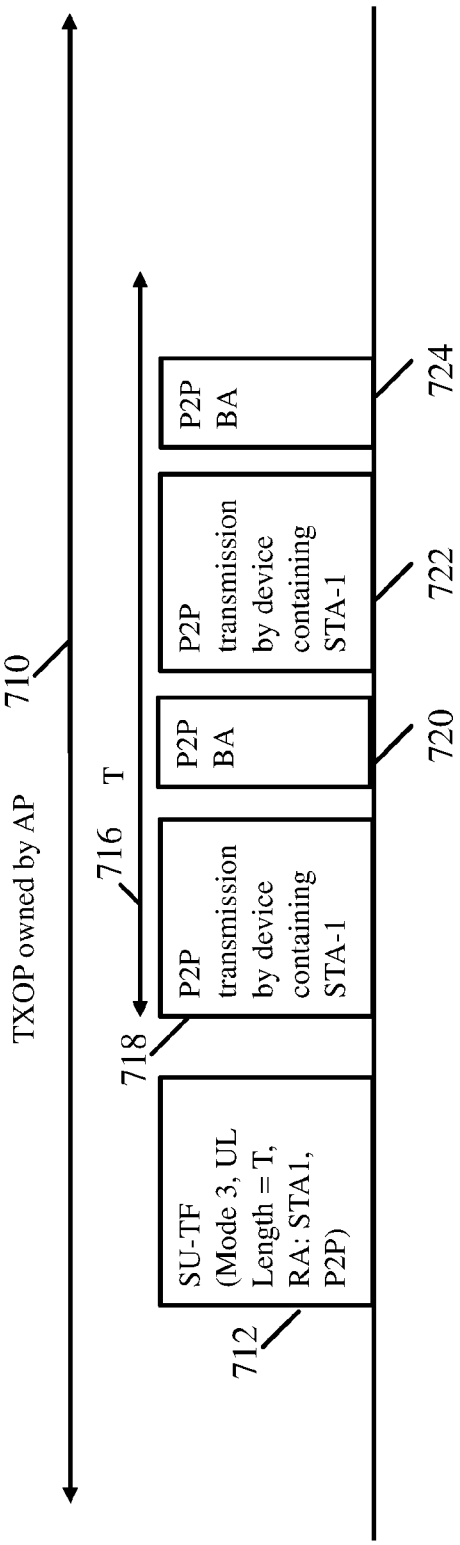
TXOP owned by AP
710
T
716
718
SU-TF (Mode 3, UL Length = T, RA: STA1, P2P)
712
P2P transmission by device containing STA-1
P2P BA
720
P2P transmission by device containing STA-1
722
P2P BA
724

Fig. 7

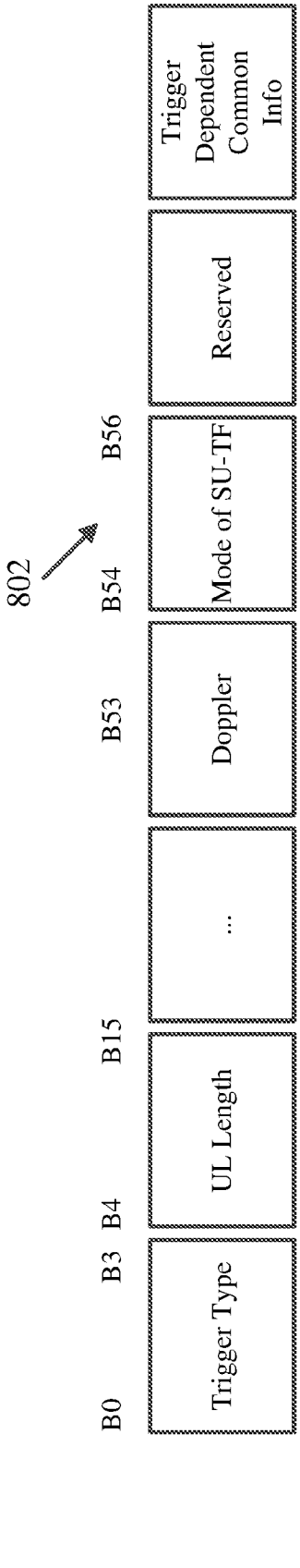
800
802
B0
B3
B4
B15
B53
B54
B56
Trigger Type
UL Length
...
Doppler
Mode of SU-TF
Reserved
Trigger Dependent Common Info

Fig. 8

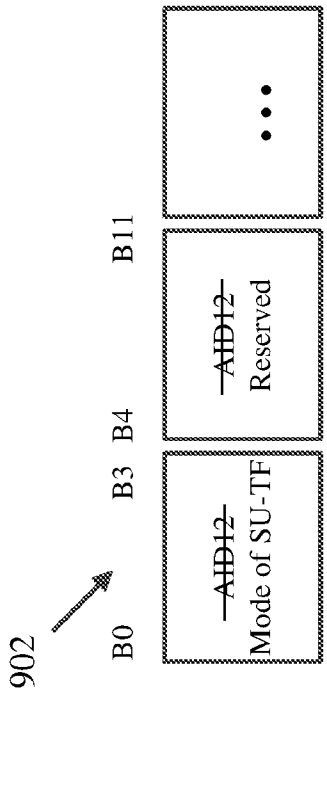

Fig. 9

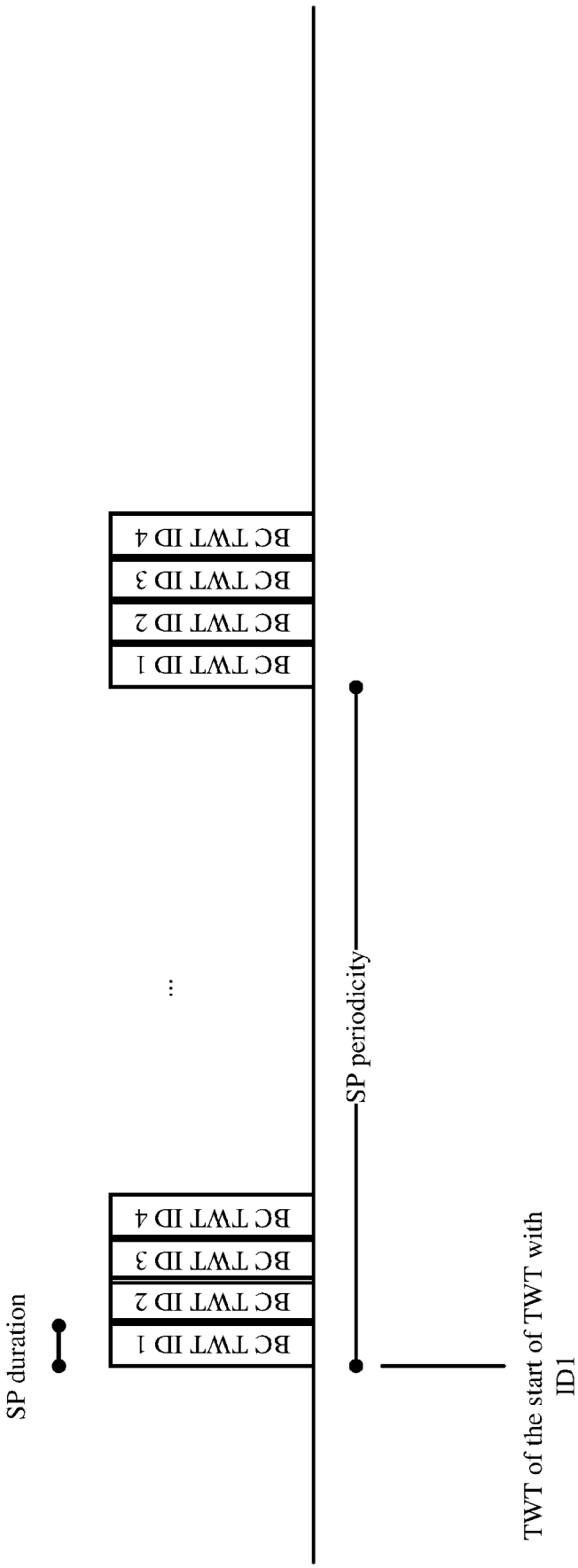
BC TWT ID 1
BC TWT ID 2
BC TWT ID 3
BC TWT ID 4
...
BC TWT ID 1
BC TWT ID 2
BC TWT ID 3
BC TWT ID 4
SP duration
SP periodicity
TWT of the start of TWT with ID1

Fig. 10

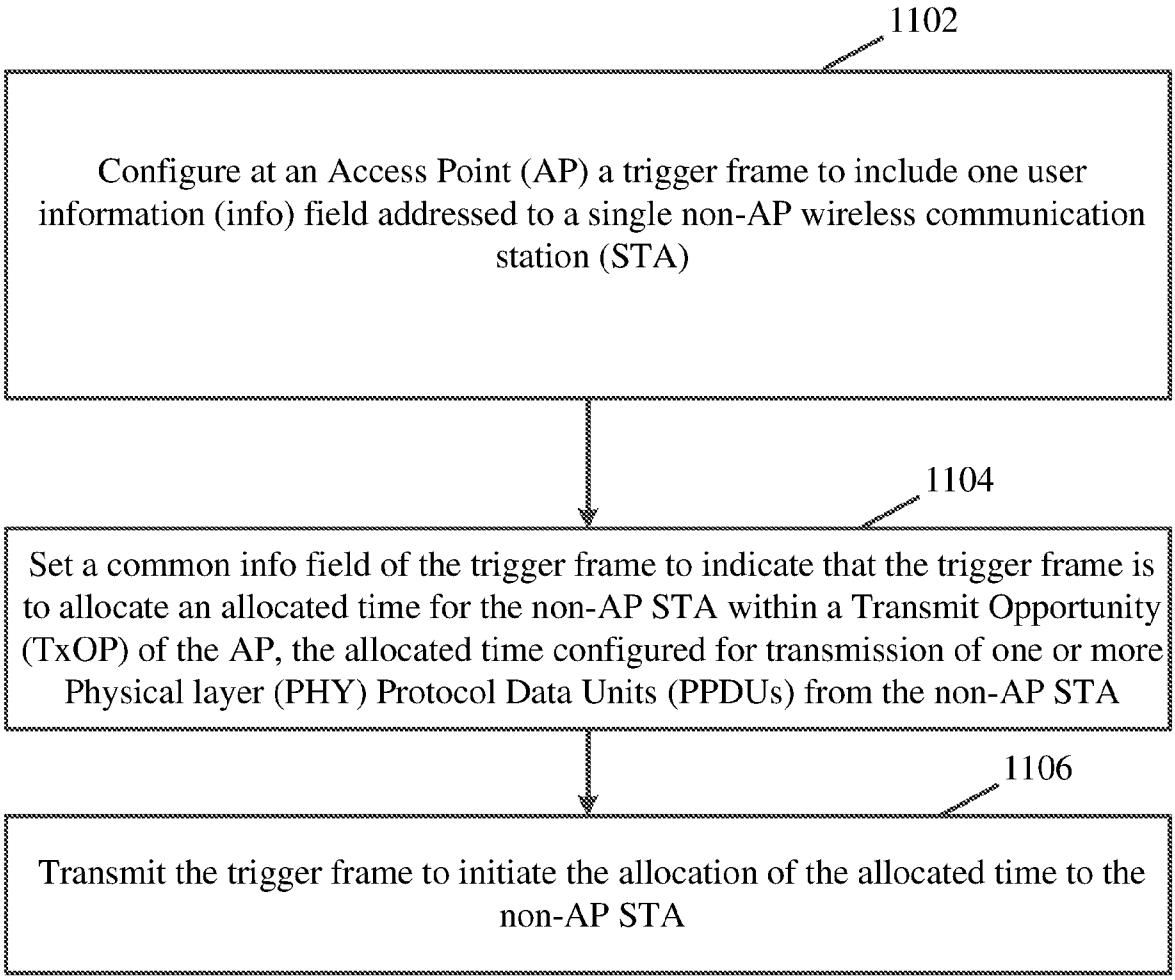
1102
Configure at an Access Point (AP) a trigger frame to include one user information (info) field addressed to a single non-AP wireless communication station (STA)
1104
Set a common info field of the trigger frame to indicate that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP, the allocated time configured for transmission of one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA
1106
Transmit the trigger frame to initiate the allocation of the allocated time to the non-AP STA

Fig. 11

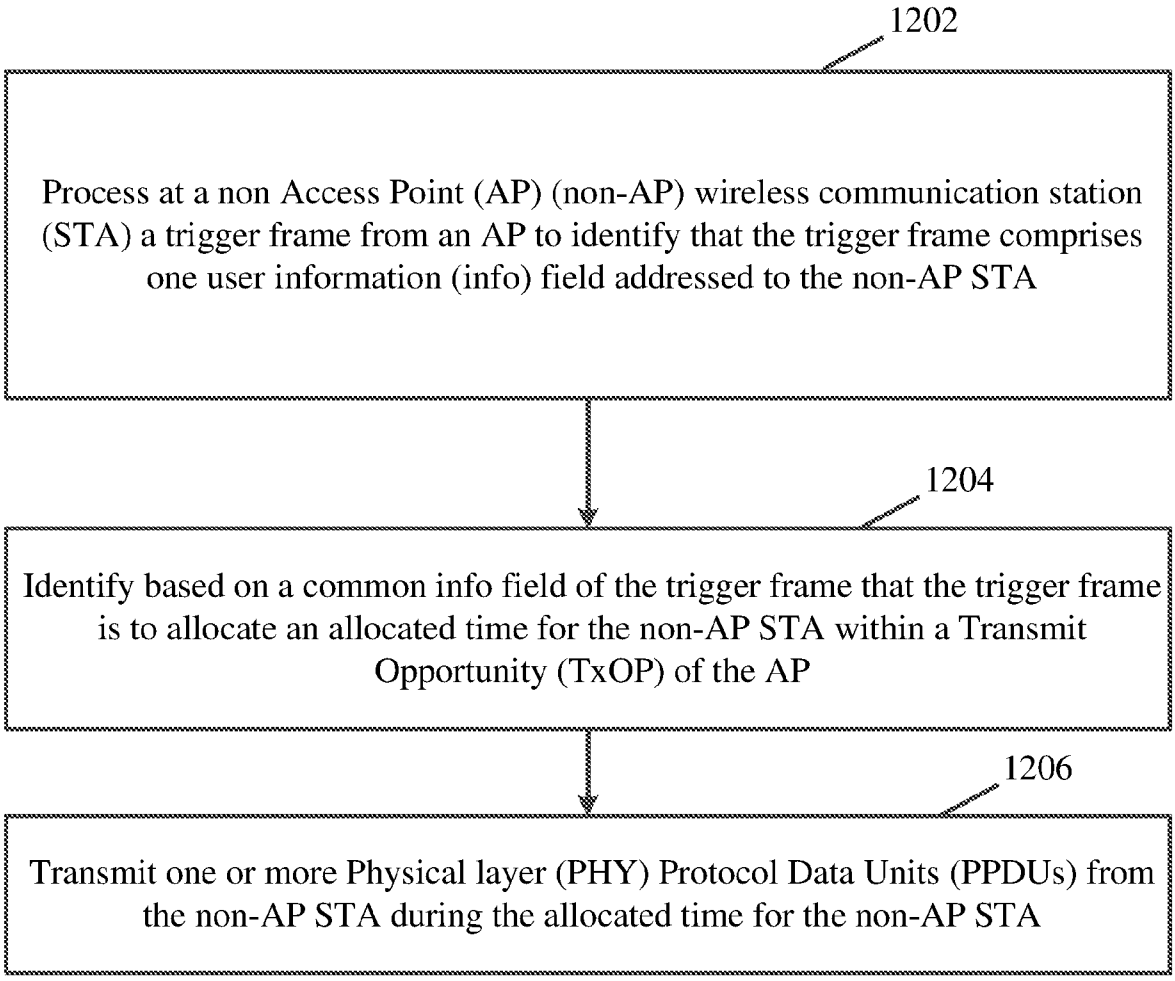
1202
Process at a non Access Point (AP) (non-AP) wireless communication station (STA) a trigger frame from an AP to identify that the trigger frame comprises one user information (info) field addressed to the non-AP STA
1204
Identify based on a common info field of the trigger frame that the trigger frame is to allocate an allocated time for the non-AP STA within a Transmit Opportunity (TxOP) of the AP
1206
Transmit one or more Physical layer (PHY) Protocol Data Units (PPDUs) from the non-AP STA during the allocated time for the non-AP STA

Fig. 12

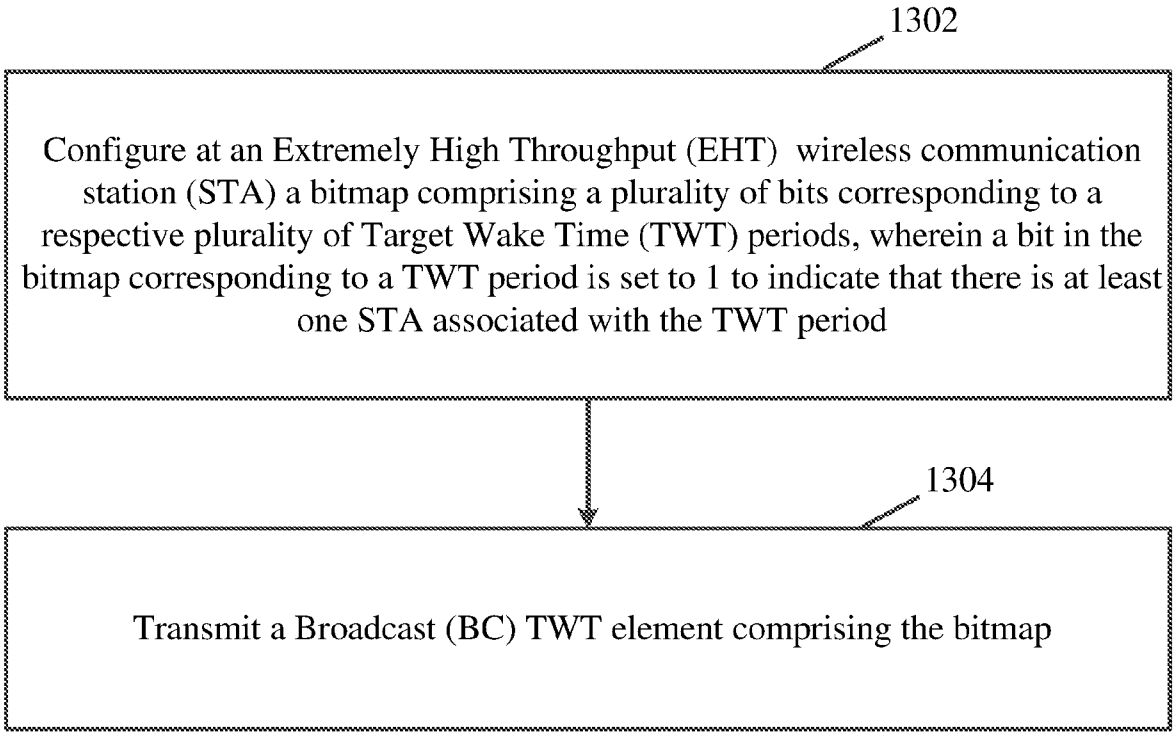
1302
Configure at an Extremely High Throughput (EHT) wireless communication station (STA) a bitmap comprising a plurality of bits corresponding to a respective plurality of Target Wake Time (TWT) periods, wherein a bit in the bitmap corresponding to a TWT period is set to 1 to indicate that there is at least one STA associated with the TWT period
1304
Transmit a Broadcast (BC) TWT element comprising the bitmap

Fig. 13

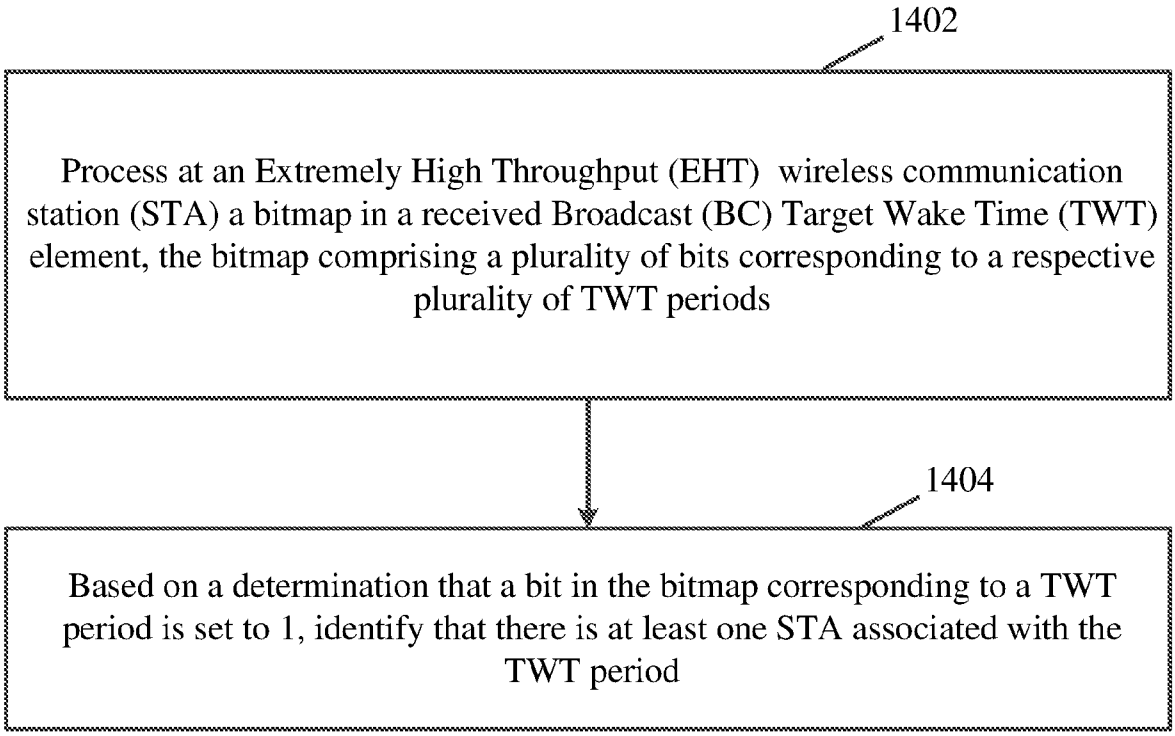
1402
Process at an Extremely High Throughput (EHT) wireless communication station (STA) a bitmap in a received Broadcast (BC) Target Wake Time (TWT) element, the bitmap comprising a plurality of bits corresponding to a respective plurality of TWT periods
1404
Based on a determination that a bit in the bitmap corresponding to a TWT period is set to 1, identify that there is at least one STA associated with the TWT period

Fig. 14

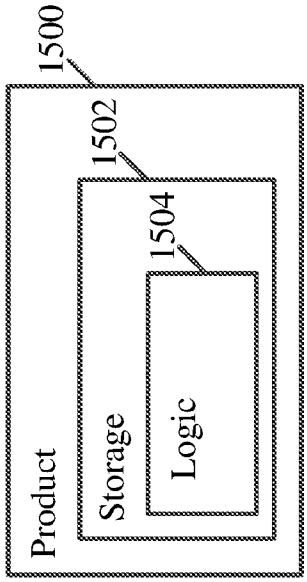

Fig. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2021/048579

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)i; **H04W 72/12**(2009.01)i; **H04L 29/08**(2006.01)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 72/04(2009.01); H04W 74/08(2009.01)

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: AP, trigger frame, user info field, common info field, mode field, allocated time

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	YOUNG HOON KWON et al., `Single STA Trigger`, IEEE 802.11-20/0689r1, 28 July 2020 slides 1-11	1,8-10,13-16,23
A		2-7,11-12,17-22,24
Y	STEPHANE BARON et al., `Triggered P2P transmissions follow up`, IEEE 802.11-20/0813r6, 08 July 2020 slides 1-17	1,8-10,13-16,23
Y	GEONJUNG KO et al., `TB PPDU Format Signaling in Trigger Frame`, IEEE 802.11-20/1192r0, 06 August 2020 slides 1-14	13
A	SUNGHYUN HWANG et al., `Multi-user Triggered P2P Transmission`, IEEE 802.11-20/0967r0, 01 July 2020 slides 1-10	1-24
A	WO 2020-013594 A1 (LG ELECTRONICS INC.) 16 January 2020 (2020-01-16) paragraphs [0136]-[0153] and figures 9-10	1-24

☐ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 December 2021	**13 December 2021**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **189 Cheongsa-ro, Seo-gu, Daejeon** **35208, Republic of Korea**	**YANG, Jeong Rok**
Facsimile No. **+82-42-481-8578**	Telephone No. **+82-42-481-5709**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2021/048579

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2020-013594 A1	16 January 2020	US 2021-0176643 A1	10 June 2021