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METHOD AND APPARATUS FOR RAMPING PREAMBLE TRANSMISSION POWER IN SUB-BAND FULL DUPLEX

Abstract

Provided are a method and apparatus for ramping preamble transmission power in a wireless communication system. The method of UE may include receiving configuration information for a first random access channel (RACH) resource type associated with a subband full duplex (SBFD) and configuration information for a second RACH resource type associated with a non-SBFD from a base station, and setting preamble received target power based on a first power ramping step according to the configuration information for the first RACH resource type and a second power ramping step according to the configuration information for the second RACH resource type. The preamble received target power may be set when the RACH resource type is changed in second preamble transmission after first preamble transmission.

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Background/Summary

CROSS-REFERENCE TO RELATED THE APPLICATION

[0001] This application is based on and claims priority under 35 U.S.C. § 119 to Patent Application No. 10-2024-0023844 filed on Feb. 19, 2024 and No. 10-2025-0009713 filed on Jan. 22, 2025 in the Korean Intellectual Property Office, the disclosures of which are incorporated by reference herein in their entirety.

BACKGROUND

Technical Field

[0002] The present disclosure relates to wireless communication applicable to 5G NR, 5G-Advanced and 6G.

Description of the Related Art

[0003] With the increase in the number of communication devices, there is a corresponding rise in communication traffic that must be managed. To address this increased communication traffic, a next generation 5G system, which is an enhanced mobile broadband communication system compared to the exiting LTE system, has become essential. Such a next generation 5G system has been designed based on scenarios which are classified into Enhanced Mobile BroadBand (eMBB), Ultra-reliability and low-latency communication (URLLC), Massive Machine-Type Communications (mMTC), and others.

[0004] eMBB, URLLC, and mMTC represent next generation mobile communication scenarios. eMBB is characterized by high spectrum efficiency, high user experience data rate, and high peak data rate. URLLC is characterized by ultra-reliable, ultra-low latency, and ultra-high availability (e.g., vehicle-to-everything (V2X), Emergency Service, and Remote Control). mMTC is characterized by low cost, low energy consumption, short packets, and massive connectivity (e.g., Internet of Things (IoT)).

SUMMARY

[0005] The disclosure is to provide a method and apparatus which can efficiently perform an operation for ramping preamble transmission power in subband full duplex communication.

[0006] According to an embodiment, a method of a user equipment (UE) may be provided for operating in a wireless communication system. The

method of the UE may include receiving configuration information about a first random access channel (RACH) resource type associated with a subband full duplex (SBFD) and configuration information about a second RACH resource type associated with a non-SBFD from a base station, setting preamble received target power based on a first power ramping step according to the configuration information for the first RACH resource type and a second power ramping step according to the configuration information for the second RACH resource type, in which the preamble received target power is set when the RACH resource type is changed in second preamble transmission after first preamble transmission.
[0007] According to another embodiment, a user equipment (UE) may be provided for operating in a wireless communication system. The UE may include at least one processor; and at least one memory configured to store instructions and operably electrically connectable to the at least one processor, wherein operations performed based on the instructions executed by the at least one processor include: receiving configuration information about a first random access channel (RACH) resource type associated with a subband full duplex (SBFD) and configuration information about a second RACH resource type associated with a non-SBFD from a base station, and setting preamble received target power based on a first power ramping step according to the configuration information for the first RACH resource type and a second power ramping step according to the configuration information for the second RACH resource type, wherein the preamble received target power is set when the RACH resource type is changed in second preamble transmission after first preamble transmission.
[0008] The UE performs the second preamble transmission using the set preamble received target power. Here, the second preamble transmission may be retransmission of the first preamble transmission.
[0009] Meanwhile, the configuration information for the first RACH resource type comprises a first parameter associated with the first power ramping step, and the configuration information for the second RACH resource type comprises a second parameter associated with the second power ramping step, in which the first parameter and the second parameter may be independent of each other.
[0010] Further, the RACH resource type corresponding to the first preamble transmission may be determined at initiation of a RACH procedure.
[0011] Further, the first RACH resource type may be a first RACH Occasion (RO) associated with the SBFD, and the second RACH resource type may be a second RO associated with the non-SBFD. Here, the first preamble transmission may be performed through the first RO, and the second preamble transmission may be performed through the second RO.
[0012] Further, the preamble received target power may be set using a power offset calculated based on the first power ramping step and the second power ramping step.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0013] FIG. **1** is a diagram illustrating a wireless communication system.
[0014] FIG. **2** is a diagram illustrating a structure of a radio frame used in new radio (NR).
[0015] FIGS. **3**A to **3**C illustrate exemplary architectures for a wireless communication service.
[0016] FIG. **4** illustrates a slot structure of an NR frame.
[0017] FIG. **5** shows an example of a subframe type in NR.
[0018] FIG. **6** illustrates a structure of a self-contained slot.
[0019] FIGS. **7**A and **7**B show schematic examples of subband full duplex communication.
[0020] FIGS. **8**A and **8**B show examples where an uplink (UL) subband is configured in a downlink (DL) slot according to an embodiment.
[0021] FIG. **9** shows an example of transmission power ramping during preamble retransmission according to an embodiment.
[0022] FIG. **10** is a flowchart showing a method of operating a UE according to an embodiment.
[0023] FIG. **11** is a flowchart showing a method of operating a UE according to another embodiment.
[0024] FIG. **12** shows power ramping for a message 1 according to an embodiment.
[0025] FIG. **13** shows power ramping for a message 1 according to another embodiment.
[0026] FIG. **14** shows power ramping for a message 1 according to still another embodiment.
[0027] FIG. **15** shows power ramping for a message 1 according to yet another embodiment.
[0028] FIG. **16** is a flowchart showing a method of operating a UE according to still another embodiment.
[0029] FIG. **17** is a block diagram showing apparatuses according to an embodiment of the disclosure.
[0030] FIG. **18** is a block diagram showing a terminal according to an embodiment of the disclosure.
[0031] FIG. **19** is a block diagram of a processor in accordance with an embodiment.
[0032] FIG. **20** is a detailed block diagram of a transceiver of a first apparatus shown in FIG. **17** or a transceiving unit of an apparatus shown in FIG. **18**.
DETAILED DESCRIPTION
[0033] The technical terms used in this document are for merely describing specific embodiments and should not be considered limiting the embodiments of disclosure. Unless defined otherwise, the technical terms used in this document should be interpreted as commonly understood by those skilled in the art but not too broadly or too narrowly. If any technical terms used here do not precisely convey the intended meaning of the disclosure, they should be replaced with or interpreted as technical terms that accurately understood by those skilled in the art. The general terms used in this document should be interpreted according to their dictionary definitions, without overly narrow interpretations.
[0034] The singular form used in the disclosure includes the plural unless the context dictates otherwise. The term ‘include’ or ‘have’ may represent the presence of features, numbers, steps, operations, components, parts or the combination thereof described in the disclosure. The term ‘include’ or ‘have’ may not exclude the presence or addition of another feature, another number, another step, another operation, another component, another part or the combination thereof.
[0035] The terms ‘first’ and ‘second’ are used to describe various components without limiting them to these specific terms. The terms ‘first’ and ‘second’ are only used to distinguish one component from another component. For example, a first component may be named as a second component without departing from the scope of the disclosure.
[0036] When an element or layer is referred to as being “connected to” or “coupled to” another element or layer, it may be directly connected or coupled to the other element or layer, there might be intervening elements or layers. In contrast, when an element or layer is referred to as being “directly connected to” or “directly coupled to” another element or layer, there are no intervening elements or layers.
[0037] Hereinafter, the exemplary embodiments of the disclosure will be described in detail with reference to the accompanying drawings. In describing the disclosure, for ease of understanding, the same reference numerals will be used throughout the drawings for the same components, and repetitive description on these components will be omitted. Detailed description on well-known arts that may obscure the essence of the disclosure will be omitted. The accompanying drawings are provided to merely facilitate understanding of the embodiment of disclosure and should not be seen as limiting. It should be recognized that the essence of this disclosure extends the illustrations, encompassing, replacements or equivalents in variations of what is shown in the drawings.
[0038] In this disclosure, “A or B” may mean “only A”, “only B”, or “both A and B”. In other words, “A or B” in the disclosure may be interpreted as “A and/or B”. For example, “A, B or C” may mean “only A”, “only B”, “only C”, or “any combination of A, B and C”.
[0039] In this disclosure, slash (/) or comma (,) may mean “and/or”. For example, “A/B” may mean “A and/or B”. Accordingly, “A/B” may mean “only A”, “only B”, or “both A and B”. For example, “A, B, C” may mean “A, B or C”.

[0040] In this disclosure, “at least one of A and B” may mean “only A”, “only B” or “both A and B”. In addition, “at least one of A or B” or “at least one of A and/or B” may be interpreted as the same as “at least one of A and B”.
[0041] In addition, “at least one of A, B and C” may mean “only A”, “only B”, “only C”, or “any combination of A, B and C”. Further, “at least one of A, B or C” or “at least one of A, B and/or C” may mean “at least one of A, B and C”.
[0042] Also, parentheses used in this disclosure may mean “for example”. For example, “control information (PDCCH)” may mean that “PDCCH” is an example of “control information”. However, “control information” in this disclosure is not limited to “PDCCH”. As another example, “control information (i.e., PDCCH)”, may also mean that “PDCCH” is an example of “control information”.
[0043] Each of the technical features described in one drawing in this disclosure may be implemented independently or simultaneously.
[0044] In the accompanying drawings, user equipment (UE) is illustrated as an example and may be referred to as a terminal, mobile equipment (ME), and the like. UE may be a portable device such as a laptop computer, a mobile phone, a personal digital assistance (PDA), a smart phone, a multimedia device, or the like. UE may be a non-portable device such as a personal computer (PC) or a vehicle-mounted device.
[0045] Hereinafter, the UE may be as an example of a device capable of wireless communication. The UE may be referred to as a wireless communication device, a wireless device, or a wireless apparatus. The operation performed by the UE may be applicable to any device capable of wireless communication. A device capable of wireless communication may also be referred to as a radio communication device, a wireless device, or a wireless apparatus.
[0046] A base station generally refers to a fixed station that communicates with a wireless device. The base station may include an evolved-NodeB (eNodeB), an evolved-NodeB (eNB), a BTS (Base Transceiver System), an access point (Access Point), gNB (Next generation NodeB), RRH (remote radio head), TP (transmission point), RP (reception point), and the repeater (relay).
[0047] While embodiments of the disclosure are described based on an long term evolution (LTE) system, an LTE-advanced (LTE-A) system, and an new radio (NR) system, such embodiments may be applicable to any communication system that fits the described criteria.
Wireless Communication System
[0048] With the success of long-term evolution (LTE)/LTE-A (LTE-Advanced) for the 4th generation mobile communication, the next generation mobile communication (e.g., 5th generation: also known as 5G mobile communication) has been commercialized and the follow-up studies are also ongoing.
[0049] The 5th generation mobile communications, as defined by the International Telecommunication Union (ITU), provide a data transmission rate of up to 20 Gbps and a minimum actual transmission rate of at least 100 Mbps anywhere. The official name of the 5th generation mobile telecommunications is ‘IMT-2020’.
[0050] ITU proposes three usage scenarios: enhanced Mobile Broadband (eMBB), massive Machine Type Communication (mMTC) and Ultra Reliable and Low Latency Communications (URLLC).
[0051] URLLC is a usage scenario requiring high reliability and low latency. For example, services such as automatic driving, factory automation, augmented reality require high reliability and low latency (e.g., a delay time of less than 1 ms). The delay time of current 4G (e.g., LTE) is statistically about 21 to 43 ms (best 10%) and about 33 to 75 ms (median), which insufficient to support services requiring a delay time of about 1 ms or less. Meanwhile, eMBB is a usage scenario that requires mobile ultra-wideband.
[0052] That is, the 5G mobile communication system offers a higher capacity compared to current 4G LTE. The 5G mobile communication system may be designed to increase the density of mobile broadband users and support device to device (D2D), high stability, and machine type communication (MTC). 5G research and development focus on achieving lower latency times and lower battery consumption compared to 4G mobile communication systems, enhancing the implementation of the Internet of things (IoTs). A new radio access technology, known as new RAT or NR, may be introduced for such 5G mobile communication.
[0053] An NR frequency band is defined to include two frequency ranges FR1 and FR2.Table 1 below shows an example of the two frequency ranges FR1 and FR2. However, the numerical values associated with each frequency range may be subject to change, and the embodiments are not limited thereto. For convenience of description, FR1 in the NR system may refer to a Sub-6 GHz range, and FR2 may refer to an above-6 GHz range, which may be called millimeter waves (mmWs).
TABLE-US-00001 TABLE 1 Frequency Range Corresponding Subcarrier designation frequency range Spacing FR1 410 MHz-7125 MHz 15, 30, 60 kHz FR2 24250 MHz-52600 MHz 60, 120, 240 kHz
[0054] The numerical values of the frequency ranges may be subject to change in the NR system. For example, FR1 may range from about 410 MHz to 7125 MHz as listed in [Table 1]. That is, FR1 may include a frequency band of 6 GHZ (or 5850, 5900, and 5925 MHz) or higher. For example, the frequency band of 6 GHz (or 5850, 5900, and 5925 MHz) or higher may include an unlicensed band. The unlicensed band may be used for various purposes, for example, vehicle communication (e.g., autonomous driving).
[0055] The 3GPP communication standards define downlink (DL) physical channels and DL physical signals. DL physical channels are related to resource elements (REs) that convey information from a higher layer while DL physical signals, used in the physical layer, correspond to REs that do not carry information from a higher layer. For example, DL physical channels include physical downlink shared channel (PDSCH), physical broadcast channel (PBCH), physical multicast channel (PMCH), physical control format indicator channel (PCFICH), physical downlink control channel (PDCCH), and physical hybrid ARQ indicator channel (PHICH). DL physical signals include reference signals (RSs) and synchronization signals (SSs). A reference signal (RS) is also known as a pilot signal and has a predefined special waveform known to both a gNode B (gNB) and a UE. For example, DL RSs include cell specific RS, UE-specific RS (UE-RS), positioning RS (PRS), and channel state information RS (CSI-RS). The 3GPP LTE/LTE-A standards also define uplink (UL) physical channels and UL physical signals. UL channels correspond to REs with information from a higher layer. UL physical signals are used in the physical layer and correspond to REs which do not carry information from a higher layer. For example, UL physical channels include physical uplink shared channel (PUSCH), physical uplink control channel (PUCCH), and physical random access channel (PRACH). UL physical signals include a demodulation reference signal (DMRS) for a UL control/data signal, and a sounding reference signal (SRS) used for UL channel measurement.
[0056] In this disclosure, PDCCH/PCFICH/PHICH/PDSCH refers to a set of time-frequency resources or a set of REs carrying downlink control information (DCI)/a control format indicator (CFI)/a DL acknowledgement/negative acknowledgement (ACK/NACK)/DL data. Further, PUCCH/PUSCH/PRACH refers to a set of time- frequency resources or a set of REs carrying UL control information (UCI)/UL data/a random access signal.
[0057] FIG. **1** is a diagram illustrating a wireless communication system.
[0058] Referring to FIG. **1**, the wireless communication system may include at least one base station (BS). For example, the BSs may include a gNodeB (or gNB) **20***a* and an eNodeB (or eNB) **20***b*. The gNB **20***a* supports 5G mobile communication. The eNB **20***b* supports 4G mobile communication, that is, long term evolution (LTE).
[0059] Each BS **20***a* and **20***b* provides a communication service for a specific geographic area (commonly referred to as a cell) (**20-1**, **20-2**, **20-3**). The cell may also be divided into a plurality of areas (referred to as sectors).
[0060] A user equipment (UE) typically belongs to one cell, and the cell to which the UE belongs is called a serving cell. A base station providing a communication service to a serving cell is referred to as a serving base station (serving BS). Since the wireless communication system is a cellular system, there are other cells adjacent to the serving cell. The other cell adjacent to the serving cell is referred to as a neighbor cell. A base station that provides a communication service to a neighboring cell is referred to as a neighbor BS. The serving cell and the neighboring cell are relatively determined based on the UE.

[0061] Hereinafter, downlink means communication from the base station **20** to the UE **10**, and uplink means communication from the UE **10** to the base station **20**. In the downlink, a transmitter may be a part of the base station **20**, and a receiver may be a part of the UE **10**. In the uplink, the transmitter may be a part of the UE **10**, and the receiver may be a part of the base station **20**.
[0062] In a wireless communication system, there are primarily two schemes: frequency division duplex (FDD) scheme and time division duplex (TDD) scheme. In the FDD scheme, uplink transmission and downlink transmission occur on different frequency bands. Conversely, the TDD scheme allows both uplink transmission and downlink transmission to use the same frequency band, but at different times. A key characteristic of the TDD scheme is the substantial reciprocity of the channel response, meaning that the downlink channel response and the uplink channel response are almost identical within a given frequency domain. This reciprocity in TDD-based radio communication systems enables the estimation of the downlink channel response from the uplink channel response. In the TDD scheme, since uplink transmission and downlink transmission are time-divided in the entire frequency band, it is not possible to simultaneously perform downlink transmission by the base station and uplink transmission by the UE. In a TDD system where uplink transmission and downlink transmission are divided into subframe units, uplink transmission and downlink transmission are performed in different subframes.
[0063] FIG. **2** is a diagram illustrating a structure of a radio frame used in new radio (NR).
[0064] In NR, UL and DL transmissions are configured in frames. Each radio frame has a length of **10** ms and is divided into two **5**-ms half frames (HFs). Each half frame is divided into five 1-ms subframes. A subframe is divided into one or more slots, and the number of slots in a subframe depends on the subcarrier spacing (SCS). Each slot includes 12 or 14 OFDM(A) symbols according to a Cyclic Prefix (CP). With a normal CP, a slot includes 14 OFDM symbols. With an extended CP, a slot includes 12 OFDM symbols. A symbol may include an OFDM symbol (CP-OFDM symbol) and an SC-FDMA symbol (or DFT-s-OFDM symbol).
Support of Various Numerologies
[0065] As wireless communication technology advances, the NR system may offer various numerologies to terminals. For example, when a subcarrier spacing (SCS) is set at 15 kHz, it supports a broad range of the typical cellular bands. When a subcarrier spacing (SCS) is set at 30 kHz/60 kHz, it supports a dense-urban, lower latency, wider carrier bandwidth. When the SCS is 60 kHz or higher, it supports a bandwidth greater than 24.25 GHz in order to overcome phase noise.
[0066] These numerologies may be defined by the cyclic prefix (CP) length and the SCS. A single cell in the NR system is capable of providing multiple numerologies to terminals. Table 2 below shows the relationship between the subcarrier spacing, corresponding CP length, and the index of a numerology (represented by μ).
TABLE-US-00002 TABLE 2 μ Δf = 2.sup.μ .Math. 15 [kHz] CP 0 15 normal 1 30 normal 2 60 normal, extended 3 120 normal 4 240 normal 5 480 normal 6 960 normal
[0067] Table 3 below shows the number of OFDM symbols per slot (N.sup.slot.sub.symb), the number of slots per frame (N.sup.frame,μ.sub.slot), and the number of slots per subframe (N.sup.subframe,μ.sub.slot) according to each numerology expressed by μ in the case of a normal CP.
TABLE-US-00003 TABLE 3 μ Δf = 2.sup.μ .Math. 15 [kHz] N.sup.slot.sub.symb N.sup.frame,μ.sub.slot N.sup.subframe,μ.sub.slot 0 15 14 10 1 1 30 14 20 2 2 60 14 40 4 3 120 14 80 8 4 240 14 160 16 5 480 14 320 32 6 960 14 640 64
[0068] Table 4 below shows the number of OFDM symbols per slot (N.sup.slot.sub.symb), the number of slots per frame (N.sup.frame,μ.sub.slot), and the number of slots per subframe (N.sup.subframe,μ.sub.slot) of a numerology represented by μ in the case of an extended CP.
TABLE-US-00004 TABLE 4 μ SCS (15*2.sup.u) N.sup.slot.sub.symb N.sup.frame,μ.sub.slot N.sup.subframe,μ.sub.slot 2 60 KHz 12 40 4
[0069] In the NR system, OFDM(A) numerologies (e.g., SCS, CP length, and so on) may be configured differently across multiple cells that are integrated with a single terminal. Accordingly, the duration of time resource may vary among these integrated cells. Here, the duration may be referred to as a section. The time resource may include a subframe, a slot or a transmission time interval (TTI). Further, the time resource may be collectively referred to as a time unit (TU) for simplicity and include the same number of symbols.
[0070] FIGS. **3**A to **3**C illustrate exemplary architectures for a wireless communication service.
[0071] Referring to FIG. **3**A, a UE is connected in dual connectivity (DC) with an LTE/LTE-A cell and a NR cell.
[0072] The NR cell is connected with a core network for the legacy fourth-generation mobile communication, that is, Evolved Packet core (EPC).
[0073] Referring to FIG. **3**B, the LTE/LTE-A cell is connected with a core network for 5th generation mobile communication, that is, a 5G core network.
[0074] A service provided by the architecture shown in FIGS. **3**A and **3**B is referred to as a non-standalone (NSA) service.
[0075] Referring to FIG. **3**C, a UE is connected only with an NR cell. A service provided by this architecture is referred to as a standalone (SA) service.
[0076] In the new radio access technology (NR), the use of a downlink subframe for reception from a base station and an uplink subframe for transmission to the base station may be employed. This method may be applicable to both paired spectrums and unpaired spectrums. Paired spectrums involve two subcarriers designated for downlink and uplink operations. For example, one subcarrier within a pair of spectrums may include a pair of a downlink band and an uplink band.
[0077] FIG. **4** illustrates a slot structure of an NR frame.
[0078] A slot in the NR system includes a plurality of symbols in the time domain. For example, in the case of the normal CP, one slot includes seven symbols. On the other hand, in the case of the extended CP, one slot includes six symbols. A carrier includes a plurality of subcarriers in the frequency domain. A resource block (RB) is defined as a set of consecutive subcarriers (e.g., 12 consecutive subcarriers) in the frequency domain. A bandwidth part (BWP) is defined as a sequence of consecutive physical resource blocks (PRBs) in the frequency domain and may be associated with a specific numerology (e.g., SCS, CP length, etc.). A terminal may be configured with up to N (e.g., five) BWPs in each of downlink and uplink. Downlink or uplink transmission is performed through an activated BWP. Among the BWPs configured for the terminal, only one BWP may be activated at a given time. In the resource grid, each element is referred to as a resource element (RE), and one complex symbol may be mapped thereto.
[0079] FIG. **5** shows an example of a subframe type in NR.
[0080] In NR (or new RAT), a Transmission Time Interval (TTI), as shown in FIG. **5**, may be referred to as a subframe or slot. The subframe (or slot) may be utilized in a TDD system to minimize data transmission delay. As shown in FIG. **5**, a subframe (or slot) includes 14 symbols. The symbol at the head of the subframe (or slot) may be allocated for a DL control channel, and the symbol at the end of the subframe (or slot) may be assigned for a UL control channel. The remaining symbols may be used for either DL data transmission or UL data transmission. This subframe (or slot) structure allows sequential downlink and uplink transmissions in one single subframe (or slot). Accordingly, downlink data may be received in a subframe (or slot) and uplink ACK/NACK may be transmitted in the same subframe (or slot).
[0081] Such a subframe (or slot) structure may be referred to as a self-contained subframe (or slot).
[0082] The first N symbols in a slot may be used to transmit a DL control channel and referred to as a DL control region, hereinafter. The last M symbols in the slot may be used to transmit a UL control channel and referred to as a UL control region. N and M are integers greater than 0. A resource region between the DL control region and the UL control region may be used for either DL data transmission or UL data transmission and referred to as a data region. For example, a physical downlink control channel (PDCCH) may be transmitted in the DL control region, and a physical downlink shared channel (PDSCH) may be transmitted in the DL data region. A physical uplink control channel (PUCCH) may be transmitted in the UL control region, and a physical uplink shared channel (PUSCH) may be transmitted in the UL data region.
[0083] Using this subframe (or slot) structure reduces the time required for retransmitting data that has failed in reception, thereby minimizing

overall data transmission latency. In such a self-contained subframe (or slot) structure, a time gap may be required for transitioning between a transmission mode and a reception mode or from the reception mode to the transmission mode. To accommodate this, a few OFDM symbols when switch from DL to UL in the subframe structure may be configured to a guard period (GP).
[0084] FIG. **6** illustrates a structure of a self-contained slot.
[0085] In the NR system, the frames are structured as a self-contained structure, where one single slot includes a DL control channel, either a DL or UL data channel, and UL control channel. For example, the first N symbols in a slot may be used for transmitting a DL control channel and referred to as a DL control region. The last M symbols in the slot may be used for transmitting an UL control channel and referred to as a UL control region. N and M are integers greater than 0. A resource region between the DL control region and the UL control region may be used for either DL data transmission or UL data transmission and referred to as a data region.
[0086] For example, the following configurations may be considered. The durations are listed in temporal order. [0087] 1. DL only configuration [0088] 2. UL only configuration [0089] 3. Mixed UL-DL configuration [0090] DL region+Guard Period (GP)+UL control region [0091] DL control region+GP+UL region [0092] DL region: (i) DL data region, (ii) DL control region+DL data region [0093] UL region: (i) UL data region, (ii) UL data region+UL control region
[0094] A physical downlink control channel (PDCCH) may be transmitted in the DL control region, and a physical downlink shared channel (PDSCH) may be transmitted in the DL data region. A physical uplink control channel (PUCCH) may be transmitted in the UL control region, and a physical uplink shared channel (PUSCH) may be transmitted in the UL data region. Through the PDCCH, Downlink Control Information (DCI), for example, DL data scheduling information or UL data scheduling data may be transmitted. Through the PUCCH, Uplink Control Information (UCI), for example, ACK/NACK (Positive Acknowledgement/Negative Acknowledgement) information with respect to DL data, Channel State Information (CSI) information, or Scheduling Request (SR) may be transmitted. A guard period (GP) provides a time gap during a process where a gNB and a UE transition from the transmission mode to the reception mode or a process where the gNB and UE transition from the reception mode to the transmission mode. Some of symbols within a subframe that transition from DL to UL mode may be configured as the GP.
[0095] Time division duplex (TDD) refers to a duplexing method widely used in commercial NR, i.e., a 5G mobile communication system. In TDD, time-duration radio resources are divided into downlink slots and uplink slots, where the downlink slots are typically distributed in a higher percentage than the uplink slots based on the distribution ratio of uplink traffic and downlink traffic. However, such limitation in the uplink slot distribution has negative effects in terms of coverage and delay time. Recently, full duplex communication has attracted attention as a technology to solve this problem.
[0096] The full duplex communication refers to technology in which the gNB, i.e., the base station performs DL transmission and UL reception simultaneously through the same (or given) radio resources. The UE may also perform DL reception and UL transmission simultaneously. In other words, both the base station and the UE may support full duplex communication. However, unlike the base station in which self-interference cancelation is structurally more feasible, the UE exhibits DL reception performance that is susceptible to self-interference from a UL transmission signal. Therefore, it is generally considered preferable to operate the gNB in full duplex communication and operate the UE in half duplex communication. In addition, the gNB may also primarily consider a subband non-overlapping full duplex communication method in which it performs DL transmission and UL reception simultaneously, but uses different frequency resources for transmission and reception, rather than the same resources between the DL and UL to reduce the effects of self-interference.
[0097] FIGS. **7**A and **7**B show schematic examples of subband full duplex communication.
[0098] The subband full duplex communication may be referred to as subband full duplex communication (SBFD) or full duplex communication subband (FDSB).
[0099] In SBFD, some time-frequency resources on a given carrier are used for the downlink, and some time-frequency resources on the same carrier are used for the uplink. Specifically, the downlink resources and the uplink resources are separated from each other in the frequency domain and used for transmission and reception.
[0100] FIGS. **7**A and **7**B show examples of SBFD. In the frequency domain, FIG. **7**A shows an example where an uplink subband is located between downlink subbands, and FIG. **7**B shows an example where the downlink subband is located between the uplink subbands. Although not shown in the drawings, a guard band or guard period may be located between the downlink subband and the uplink subband to reduce interference.
[0101] FIGS. **8**A and **8**B show examples where an uplink (UL) subband is configured in a downlink (DL) slot according to an embodiment of the present specification.
[0102] Referring to FIGS. **8**A and **8**B, if the TDD is configured at a ratio of 4:1 between DL slots and UL slots in any NR frequency band (where, the last DL slot is a special slot of which some symbols include flexible symbols for DL/UL transition), the UL subband may be configured to support the UL transmission of the UE in some (or all) DL slots among the corresponding DL slots. When the UL subband is configured in any DL slot, the UL subband may be configured either at the center or at the edge of the corresponding frequency band as shown in FIGS. **8**A and **8**B, and a guard band may be configured between the UL subband and the DL subband in the corresponding slot.
[0103] Meanwhile, the remaining frequency resources, excluding the UL subband and the guard band, may be used as the DL subbands for the DL transmission and reception according to the existing slot/symbol configuration information. As shown in FIG. **8**A, when the UL subband is configured at the center of the frequency band, a total of two guard bands, one at the top and one at the bottom, are configured around the corresponding UL subband, followed by a total of two DL subbands, one at the top and one at the bottom, are configured. Alternatively, as shown in FIG. **8**B, when the UL subband is configured at the edge of the frequency band, one guard band and one DL subband may be configured adjacent to the corresponding UL subband.
[0104] In the existing NR, the UL-DL slots are defined to be configured in units of cells through cell-specific RRC signaling. In other words, the patterns of DL symbol, UL symbol, and flexible symbol having certain periods are configured through ‘tdd-UL-DL-ConfigurationCommon’, i.e., the RRC message/information for the corresponding UL-DL slot configuration. In addition, only the flexible symbol configured through the ‘tdd-UL-DL-ConfigurationCommon’ may be reallocated to the UL symbol, DL symbol or flexible symbol through the UE-specific RRC signaling, i.e., ‘tdd-UL-DL-ConfigurationDedicated’. Alternatively, a method of indicating a dynamic slot format through a UE-group common PDCCH has also been defined. To this end, the NR also supports a dynamic slot format indication method through DCI format 2_0.
[0105] According to the existing slot configuration method described above, any one symbol may be configured or indicated as the DL, UL or flexible symbol. For example, as shown in FIG. **8**A, any slot format may be configured to DDDSU through the existing slot configuration. D refers to a downlink slot, and means that all OFDM symbols constituting the corresponding slot are configured to DL. U refers to an uplink slot, and means that all OFDM symbols constituting the corresponding slot are configured to UL. S refers to a special slot, and means that flexible symbols for DL/UL transition are included in the corresponding slot. Generally, the corresponding special slot in the case of a normal CP may include a total of 14 symbols, i.e., 12 DL symbols and 2 flexible symbols. Alternatively, the special slot may include 10 DL symbols, 2 flexible symbols, and 2 UL symbols. That is, one symbol in any TDD carrier is configured or indicated as only one of the DL, UL, or flexible symbols.
[0106] However, as shown in FIGS. **8**A and **8**B, when the UL subband is configured in any DL slot, the DL transmission or UL transmission may occur simultaneously for each frequency resource in the corresponding symbol. In this way, the DL slot or symbol including the UL subband, or the UL slot or symbol including the DL subband will be referred to as an SBFD slot or SBFD symbol in this specification.
[0107] Further, in this specification, a slot including only the SBFD symbols will be referred to as the SBFD slot, and a slot including only the symbols based on the existing symbol configuration (i.e., a slot including only symbols excluding the UL subband, DL subband, and the guard band) will be referred to as a non-SBFD slot. Alternatively, a slot including at least one SBFD symbol may also be referred to as an SBFD slot.

[0108] Meanwhile, an idle/inactive UE in the current NR performs a random access procedure for the purpose of initial access. Information for this may be received through the "RACH-ConfigCommon information element (IE)" of the system information block 1 (SIB1). A cell that supports 2-step RACH includes "RACH-ConfigCommonTwoStepRA IE" to allow the UEs to perform the initial access through the 2-step RA procedure. The IE may refer to the standard specification TS 38.331.
[0109] If the base station supports the subband non-overlapping full duplex, it is considered to configure additional PRACH resources beyond the PRACH resources of the non-SBFD slot to transmit the PRACH preamble through the corresponding UL subband within the SBFD symbol or SBFD slot where the UL subband is configured as described above. This may not only increase the RACH resources of the UE but also help solve RACH delay issues that may occur in the TDD. However, the SBFD area is defined to utilize part of the typical DL resources, and thus DL interference may occur in the SBFD slot if the preamble transmission power is configured at the same level as that of the non-SBFD slot when the UE transmits the PRACH preamble in the subband of the same slot. Taking this problem into account, the transmission power for the RACH preamble transmitted in the SBFD slot may be configured differently from the transmission power for the RACH preamble configured in the non-SBFD slot.
[0110] FIG. **9** shows an example of transmission power ramping during preamble retransmission according to an embodiment of the disclosure.
[0111] Referring to FIG. **9**, the preamble transmission power in the RACH procedure is stepwise increased to a configured level each time when the preamble is retransmitted, so that the preamble is retransmitted at a higher power level than that of the previous transmission. Currently, NR does not increase PREAMBLE_POWER_RAMPING_COUNTER if PREAMBLE_POWER_RAMPING_COUNTER is greater than 1 and satisfies at least one of the following conditions. If the counter (CNT) is not increased, the preamble is retransmitted without power ramping. Here, the term 'preamble' in the RACH procedure may be used interchangeably with a 'message 1' as they have the same meaning. [0112] Condition 1: when a notification to suspend a power ramping counter is received from a lower layer [0113] Condition 2: when a Listen-Before-Talk (LBT) failure indication is received from the lower layer for the last preamble transmission [0114] Condition 3: when a Synchronization Signal Block (SSB)/Channel State Information-Reference Signal (CSI-RS) is changed [0115] Condition 4: when random access (RA) is started with a PDCCH order for a Lower-layer Triggered Mobility (LTM) candidate cell
[0116] If the preamble power ramping steps in the SBFD slot and the non-SBFD slot are configured differently, and the RA procedures of the SBFD slot and non-SBFD slot are selectively usable during the ongoing RA (for example, if the SBFD slot was used to transmit the initial preamble but the non-SBFD slot was required for the retransmission, or vice versa), it is necessary to define how to apply the power ramping step when retransmitting the preamble.
[0117] In this disclosure, schemes and corresponding RACH procedures for efficiently applying the PRACH transmission power of the UE are defined if both the PRACH resource allocated to the SBFD slot and the PRACH resource allocated to the non-SBFD slot are present as the RACH resources available to the UE. That is, if the power ramping step for the RACH resource allocated to the SBFD slot is different from the power ramping step for the RACH resource allocated to the non-SBFD slot, transmission power ramping schemes suitable for the selected slot when the UE retransmits the preamble are defined.
[0118] In more detail, for a UE that has received both configuration information related to the RACH resources in the non-SBFD slot and configuration information related to the RACH resources in the SBFD slot, it is assumed that the UE can transmit the preamble through one of two areas. In this case, when the preamble is retransmitted in the ongoing RACH procedure, if the resource of a slot belonging to an area different from the last transmitted preamble is selected for retransmission, this disclosures proposes which power ramping step the UE needs to apply and whether to increase the power ramping counter.
[0119] FIG. **10** is a flowchart showing a method of operating a UE according to an embodiment.
[0120] Referring to FIG. **10**, the UE receives two random access channel (RACH) configuration information, one for a first slot and the other for a second slot from the base station (S**1001**). Here, the first slot and the second slot may correspond to the SBFD slot and the non-SBFD slot, respectively.
[0121] Then, if the UE selects the random access (RA) resource in the slot different from the slot of the previous transmission when retransmitting the preamble, the preamble retransmission is performed without increasing the power ramping counter (S**1002**).
[0122] FIG. **11** is a flowchart showing a method of operating a UE according to another embodiment of the present specification.
[0123] Referring to FIG. **11**, the UE receives two random access channel (RACH) configuration information, one for a first slot and the other for a second slot from the base station (S**1101**). Here, the first slot and the second slot may correspond to the SBFD slot and the non-SBFD slot, respectively.
[0124] Then, if the UE selects a random access (RA) resource in a slot different from the slot of the previous transmission when retransmitting the preamble, the preamble retransmission is performed by applying a power ramping offset (S**1102**).
[0125] Meanwhile, the UE may receive an RRC message containing both an information element (IE) including a power ramping step for the RACH resource allocated to the SBFD slot and an IE including a power ramping step for the RACH resource allocated to the non-SBFD slot. The UE that has received both the two information described above needs to set two power ramping step parameters when setting RACH-related parameters. That is, the UE additionally defines SBFD_PREAMBLE_POWER_RAMPING_STEP, so that the power ramping step configured for the SBFD resources is applied, in addition to PREAMBLE_POWER_RAMPING_STEP.
[0126] According to the disclosure, at least one of the following four schemes may be used to apply both the SBFD_PREAMBLE_POWER_RAMPING_STEP and PREAMBLE_POWER_RAMPING_STEP.
[0127] Scheme 1: The slot selected in transmitting the initial preamble is also selected for the RA resources to be retransmitted.
[0128] In scheme 1, only the RA resources of the first selected slot are selected, ensuring that the preamble is retransmitted while continuously applying the parameters for the selected resource.
[0129] FIG. **12** shows power ramping for a message 1 according to an embodiment of the present specification.
[0130] Hereinafter, operations of a UE based on the scheme 1 described above will be described in detail with reference to FIG. **12**.
[0131] The UE receives i) RACH resource information belonging to the SBFD slot (RACH Occasion (RO) type=SBFD) and ii) RACH resource information belonging to the non-SBFD slot (RO type=non-SBFD) from the base station.
[0132] If the preamble transmission counter is greater than 1 and the RO type for the last preamble transmission is the SBFD, the preamble received target power is set as follows.
[0133] "set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPowerSBFD+DELTA_PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×SBFD_PREAMBLE_POWER_RAMPING_STEP+POWER_OFFSET_2STEP RA"
[0134] If the preamble transmission counter is greater than 1 and the RO type for the last preamble transmission is the non-SBFD, the preamble received target power is set as follows.
[0135] "set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPower+DELTA PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×PREAMBLE_POWER_RAMPING_STEP+POWER_OFFSET_2STEP RA"
[0136] The UE transmits the RA preamble to the base station based on the preset preamble received target power.
[0137] Scheme 2: If the RA resource to be retransmitted is switched from the SBFD to the non-SBFD or from the non-SBFD to the SBFD, the parameter value set for the selected slot is applied as is, and the power ramping counter is increased by 1.
[0138] If preambleReceivedTargetPowerSBFD and powerRampingStepSBFD are set as the RA parameters for the SBFD resources, and preambleReceivedTargetPower and powerRampingStep are set as the RA parameters for the non-SBFD resources, the parameter values for the resource selected when transmitting the preamble are applied as is, and the power ramping counter is increased by 1, regardless of switching between

the SBFD and the non-SBFD.
[0139] For example, if “power ramping counter=0” and the preamble is transmitted through the resources for the SBFD, the UE sets PREAMBLE RECEIVED_TARGET_POWER by applying the preamble received target power and preamble power ramping step for the SBFD and applying “power ramping counter=0” as follows.
[0140] “set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPowerSBFD+DELTA PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×PREAMBLE_POWER_RAMPING_STEP_SBFD+POWER_OFFSET_2STEP_RA”
[0141] If the non-SBFD resource is selected for retransmission, the UE sets PREAMBLE_RECEIVED_TARGET_POWER by applying the preamble received target power and preamble power ramping step for the non-SBFD and applying “power ramping counter=1” as follows.
[0142] “set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPower+DELTA_PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×PREAMBLE_POWER_RAMPING_STEP+POWER_OFFSET_2STEP RA”
[0143] Then, even if the SBFD resource is selected during retransmission, the UE sets PREAMBLE_RECEIVED_TARGET_POWER by applying the preamble received target power and preamble power ramping step for the SBFD and applying “power ramping counter=2” as follows.
[0144] “set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPowerSBFD+DELTA PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×PREAMBLE POWER_RAMPING_STEP_SBFD+POWER_OFFSET_2STEP_RA”
[0145] FIG. **13** shows power ramping for a message 1 according to another embodiment.
[0146] Hereinafter, operations of a UE based on the scheme 2 will be described in detail with reference to FIG. **13**.
[0147] The UE receives i) RACH resource information belonging to the SBFD slot (RO type=SBFD) and ii) RACH resource information belonging to the non-SBFD slot (RO type=non-SBFD) from the base station.
[0148] If the preamble transmission counter is greater than 1 and the selected RO type is the SBFD, the preamble received target power is set as follows.
[0149] “set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPowerSBFD+DELTA_PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×SBFD_PREAMBLE_POWER_RAMPING_STEP+POWER_OFFSET_2STEP_RA”
[0150] If the preamble transmission counter is greater than 1 and the selected RO type is the non-SBFD, the preamble received target power is set as follows.
[0151] “set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPower+DELTA_PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×PREAMBLE_POWER_RAMPING_STEP+POWER_OFFSET_2STEP_RA”
[0152] The UE transmits the RA preamble to the base station based on the preset preamble received target power.
[0153] Scheme 3: If the RA resource to be retransmitted is switched from the non-SBFD to the SBFD, the parameter value set for the selected slot is applied as is, and the power ramping counter is not increased.
[0154] In general, the non-SBFD resources do not need to consider the DL interference, and thus data may be transmitted using higher power. In this regard, it is proposed not to increase the power ramping counter only when switching from the non-SBFD to the SBFD. This approach may be preferably applied when the same power-related parameters for the RA resources are configured for both the SBFD and the non-SBFD.
[0155] That is, if the RO type selected for the last RA preamble transmission was the non-SBFD and the selected RO type is not the SBFD, the preamble power ramping counter is increased by 1.
[0156] FIG. **14** shows power ramping for a message 1 according to still another embodiment.
[0157] Hereinafter, operations of a UE based on the foregoing scheme 3 will be described in detail with reference to FIG. **14**.
[0158] The UE receives i) RACH resource information belonging to the SBFD slot (RO type=SBFD) and ii) RACH resource information belonging to the non-SBFD slot (RO type=non-SBFD) from the base station.
[0159] The UE increases the power ramping counter by 1 under the conditions described below. In other words, [0160] >if PREAMBLE_TRANSMISSION_COUNTER is greater than one; and [0161] >if the notification of suspending power ramping counter has not been received from lower layers; and) [0162] >if LBT failure indication was not received from lower layers for the last Random Access Preamble transmission; and [0163] >if SSB or CSI-RS selected is not changed from the selection in the last Random Access Preamble transmission; and [0164] >if the Random Access procedure is not initiated by the PDCCH order for an LTM candidate cell; and) [0165] >if RO type selected is not SBFD; and [0166] >if RO type selected in the last Random Access Preamble transmission was SBFD; [0167] the preamble received target power is set using the power ramping counter according to these conditions described above, and the RA preamble is transmitted to the base station.
[0168] Scheme 4: If the RA resources to be retransmitted are switched from the SBFD to the non-SBFD or from the non-SBFD to the SBFD, the power ramping offset is calculated, and power equivalent to the offset is added to or subtracted from PREAMBLE_RECEIVED_TARGET_POWER, thereby compensating for the power ramping difference between them.
[0169] That is, it is proposed to define Power_Offset_SBFD_RA, and to subtract Power_Offset_SBFD_RA for the SBFD and add Power_Offset_SBFD_RA for the non-SBFD when switching between the SBFD and the non-SBFD, if the power ramping counter is greater than 2. Here, power_offset_SBFD_RA may be set as follows.
[0170] “POWER_OFFSET_SBFD_RA={(PREAMBEL_POWER_RAMPING_COUNTER−1)*(PREAMBLE_POWER_STEP−SBFD_PREAMBLE_POWER_STEP)}/C. Where, C is a constant.”
[0171] FIG. **15** shows power ramping for a message 1 according to yet another embodiment.
[0172] Hereinafter, operations of a UE based on the scheme 4 will be described in detail with reference to FIG. **15**.
[0173] The UE receives i) RACH resource information belonging to the SBFD slot (RO type=SBFD) and ii) RACH resource information belonging to the non-SBFD slot (RO type=non-SBFD) from the base station.
[0174] Depending on the settings of the RA type specific variables, a power offset value to be applied when the RO type (i.e. SBFD or non-SBFD) of the RA is changed may be defined as follows.
[0175] If RO_TYPE is switched between SBFD and non-SBFD during this Random Access procedure:
[0176] “set POWER_OFFSET_SBFD_RA to {(PREAMBLE_POWER_RAMPING_COUNTER−1)×(PREAMBLE_POWER_RAMPING_STEP−SBFD_PREAMBLE_POWER_RAMPING_STEP)}/2.”
[0177] If the selected RO_TYPE is the SBFD, the previously calculated power offset is set for subtraction as follows,
[0178] “set PREAMBLE_RECEIVED_TARGET_POWER to preambleReceivedTargetPowerSBFD+DELTA_PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×SBFD_PREAMBLE_POWER_RAMPING_STEP+POWER_OFFSET_2STEP_RA−POWER_OFFSE
[0179] If the selected RO_TYPE is the non-SBFD, the previously calculated power offset is set for addition as follows.
[0180] “set PREAMBLE_RECEIVED_TARGET-POWER to preambleReceivedTargetPower+DELTA PREAMBLE+(PREAMBLE_POWER_RAMPING_COUNTER−1)×PREAMBLE_POWER_RAMPING_STEP+POWER_OFFSET_2STEP_RA+POWER_OFFSET_SBFI
[0181] The UE transmits the RA preamble to the base station based on the preset preamble received target power.
[0182] FIG. **16** is a flowchart showing a method of operating a UE according to still another embodiment of the present specification.
[0183] Referring to FIG. **16**, a UE receives i) configuration information for a first random access channel (RACH) resource type associated with a subband full duplex (SBFD) and ii) configuration information for a second RACH resource type associated with a non-SBFD from a base station (S**1601**).
[0184] Then, the UE sets preamble received target power based on a) a first power ramping step according to the configuration information for the first RACH resource type and b) a second power ramping step according to the configuration information for the second RACH resource type

(S**1602**). Here, the preamble received target power may be set when the RACH resource type is changed in second preamble transmission after first preamble transmission.
[0185] The UE may perform the second preamble transmission using the set preamble received target power, where the second preamble transmission may be retransmission of the first preamble transmission.
[0186] Meanwhile, the configuration information for the first RACH resource type may include a first parameter associated with the first power ramping step, and the configuration information for the second RACH resource type may include a second parameter associated with the second power ramping step, where the first parameter and the second parameter may be independent of each other.
[0187] In addition, the RACH resource type corresponding to the first preamble transmission may be determined at the initiation of a RACH procedure.
[0188] Further, the first RACH resource type may be a first RACH Occasion (RO) associated with the SBFD, and the second RACH resource type may be a second RO associated with the non-SBFD. Here, the first preamble transmission may be performed through the first RO, and the second preamble transmission may be performed through the second RO.
[0189] In addition, the preamble received target power may be set using a power offset calculated based on the first power ramping step and the second power ramping step.
[0190] The embodiments described so far may be implemented through various means. For example, the embodiments may be implemented by hardware, firmware, software, or a combination thereof. Specifically, the implementation will be described below with reference to the accompanying drawings.
[0191] FIG. **17** is a block diagram showing apparatuses according to an embodiment of the disclosure.
[0192] Referring to FIG. **17**, a wireless communication system may include a first apparatus **100***a* and a second apparatus **100***b*.
[0193] The first apparatus **100***a* may include a base station, a network node, a transmission terminal, a reception terminal, a wireless apparatus, a radio communication device, a vehicle, a vehicle with an autonomous driving function, a connected car, an unmanned aerial vehicle (UAV), an artificial intelligence (AI) module, a robot, an augmented reality (AR) apparatus, a virtual reality (VR) apparatus, a mixed reality (MR) apparatus, a hologram apparatus, a public safety apparatus, a machine-type communication (MTC) apparatus, an Internet of things (IoT) apparatus, a medial apparatus, a finance technology (FinTech) apparatus (or a financial apparatus), a security apparatus, a climate/environment apparatus, an apparatus related to a 5G service, or other apparatuses related to the fourth industrial revolution.
[0194] The second apparatus **100***b* may include a base station, a network node, a transmission terminal, a reception terminal, a wireless apparatus, a radio communication device, a vehicle, a vehicle with an autonomous driving function, a connected car, an unmanned aerial vehicle (UAV), an artificial intelligence (AI) module, a robot, an augmented reality (AR) apparatus, a virtual reality (VR) apparatus, a mixed reality (MR) apparatus, a hologram apparatus, a public safety apparatus, a machine-type communication (MTC) apparatus, an Internet of things (IoT) apparatus, a medial apparatus, a finance technology (FinTech) apparatus (or a financial apparatus), a security apparatus, a climate/environment apparatus, an apparatus related to a 5G service, or other apparatuses related to the fourth industrial revolution.
[0195] The first apparatus **100***a* may include at least one processor such as a processor **1020***a*, at least one memory such as a memory **1010***a*, and at least one transceiver such as a transceiver **1031***a*. The processor **1020***a* may be tasked with executing the previously mentioned functions, procedures, and/or methods. The processor **1020***a* may be capable of implementing one or more protocols. For example, the processor **1020***a* may perform and manage one or more layers of a radio interface protocol. The memory **1010***a* may be connected to the processor **1020***a*, and configured to store various types of information and/or instructions. The transceiver **1031***a* may be connected to the processor **1020***a*, and controlled to transceive radio signals.
[0196] The second apparatus **100***b* may include at least one processor such as a processor **1020***b*, at least one memory device such as a memory **1010***b*, and at least one transceiver such as a transceiver **1031***b*. The processor **1020***b* may be tasked with executing the previously mentioned functions, procedures, and/or methods. The processor **1020***b* may be capable of implementing one or more protocols. For example, the processor **1020***b* may manage one or more layers of a radio interface protocol. The memory **1010***b* may be connected to the processor **1020***b* and configured to store various types of information and/or instructions. The transceiver **1031***b* may be connected to the processor **1020***b* and controlled to transceive radio signaling.
[0197] The memory **1010***a* and/or the memory **1010***b* may be respectively connected inside or outside the processor **1020***a* and/or the processor **1020***b* and connected to other processors through various technologies such as wired or wireless connection.
[0198] The first apparatus **100***a* and/or the second apparatus **100***b* may have one or more antennas. For example, an antenna **1036***a* and/or an antenna **1036***b* may be configured to transceive a radio signal.
[0199] FIG. **18** is a block diagram showing a terminal (e.g., user equipment: UE) according to an embodiment of the disclosure.
[0200] In particular, FIG. **18** illustrates the previously described apparatus of FIG. **17** in more detail.
[0201] The apparatus includes a memory **1010**, a processor **1020**, a transceiving unit **1031** (e.g., transceiving circuit), a power management module **1091** (e.g., power management circuit), a battery **1092**, a display **1041**, an input unit **1053** (e.g., input circuit), a loudspeaker **1042**, a microphone **1052**, a subscriber identification module (SIM) card, and one or more antennas. Some of the constituent elements is referred to as a unit in the disclosure. However, the embodiments are not limited thereto. For example, such term “unit” is also referred to as a circuit block, a circuit, or a circuit module.
[0202] The processor **1020** may be configured to implement the proposed functions, procedures, and/or methods described in the disclosure. The layers of the radio interface protocol may be implemented in the processor **1020**. The processor **1020** may include an application-specific integrated circuit (ASIC), other chipsets, logic circuits, and/or data processing devices. The processor **1020** may be an application processor (AP). The processor **1020** may include at least one of a digital signal processor (DSP), a central processing unit (CPU), a graphics processing unit (GPU), and a modulator and demodulator (MODEM). For example, the processor **1020** may be SNAPDRAGON™ series of processors made by Qualcomm®, EXYNOS™ series of processors made by Samsung®, A series of processors made by Apple®, HELIO™ series of processors made by MediaTek®, ATOM™ series of processors made by Intel®, KIRIN™ series of processors made by HiSilicon®, or the corresponding next-generation processors.
[0203] The power management module **1091** manages a power for the processor **1020** and/or the transceiver **1031**. The battery **1092** supplies power to the power management module **1091**. The display **1041** outputs the result processed by the processor **1020**. The input unit **1053** may be an individual circuit that receives an input from a user or other devices and convey the received input with associated information to the processor **1020**. However, the embodiments are not limited thereto. For example, the input unit **1053** may be implemented as at least one of touch keys or buttons to be displayed on the display **1041** when the display **1041** is capable of sensing touches, generating related signals according to the sensed touches, and transferring the signals to the processor **1020**. The SIM card is an integrated circuit used to securely store international mobile subscriber identity (IMSI) used for identifying a subscriber in a mobile telephoning apparatus such as a mobile phone and a computer and the related key. Many types of contact address information may be stored in the SIM card.
[0204] The memory **1010** is coupled with the processor **1020** in a way to operate and stores various types of information to operate the processor **1020**. The memory may include read-only memory (ROM), random access memory (RAM), flash memory, a memory card, a storage medium, and/or other storage device. The embodiments described in the disclosure may be implemented as software program or application. In this case, such software program or application may be stored in the memory **1010**. In response to a predetermined event, the software program or application stored in the memory **1010** may be fetched and executed by the processor **1020** for performing the function and the method described in this disclosure. The memory may be implemented inside of the processor **1020**. Alternatively, the memory **1010** may be implemented outside of the processor **1020** and

may be connected to the processor **1020** in communicative connection through various means which is well-known in the art.
[0205] The transceiver **1031** is connected to the processor **1020**, receives, and transmits a radio signal under control of the processor **1020**. The transceiver **1031** includes a transmitter and a receiver. The transceiver **1031** may include a baseband circuit to process a radio frequency signal. The transceiver controls one or more antennas to transmit and/or receive a radio signal. In order to initiate a communication, the processor **1020** transfers command information to the transceiver **1031** to transmit a radio signal that configures a voice communication data. The antenna functions to transmit and receive a radio signal. When receiving a radio signal, the transceiver **1031** may transfer a signal to be processed by the processor **1020** and transform a signal in baseband. The processed signal may be transformed into audible or readable information output through the speaker **1042**.
[0206] The speaker **1042** outputs a sound related result processed by the processor **1020**. The microphone **1052** receives audio input to be used by the processor **1020**.
[0207] A user inputs command information like a phone number by pushing (or touching) a button of the input unit **1053** or a voice activation using the microphone **1052**. The processor **1020** processes to perform a proper function such as receiving the command information, calling a call number, and the like. An operational data on driving may be extracted from the SIM card or the memory **1010**. Furthermore, the processor **1020** may display the command information or driving information on the display **1041** for a user's recognition or for convenience.
[0208] FIG. **19** is a block diagram of a processor in accordance with an embodiment.
[0209] Referring to FIG. **19**, a processor **1020** may include a plurality of circuits to implement the proposed functions, procedures and/or methods described herein. For example, the processor **1020** may include a first circuit **1020-1**, a second circuit **1020-2**, and a third circuit **1020-3**. Also, although not shown, the processor **1020** may include more circuits. Each circuit may include a plurality of transistors.
[0210] The processor **1020** may be referred to as an application-specific integrated circuit (ASIC) or an application processor (AP) and may include at least one of a digital signal processor (DSP), a central processing unit (CPU), and a graphics processing unit (GPU).
[0211] FIG. **20** is a detailed block diagram of a transceiver of a first apparatus shown in FIG. **17** or a transceiving unit of an apparatus shown in FIG. **18**.
[0212] Referring to FIG. **20**, the transceiving unit **1031** (e.g., transceiving circuit) includes a transmitter **1031-1** and a receiver **1031-2**. The transmitter **1031-1** includes a discrete Fourier transform (DFT) unit **1031-11** (e.g., DFT circuit), a subcarrier mapper **1031-12** (e.g., subcarrier mapping circuit), an IFFT unit **1031-13** (e.g., IFFT circuit), a cyclic prefix (CP) insertion unit **1031-14** (e.g., CP insertion circuit), and a wireless transmitting unit **1031-15** (e.g., wireless transmitting circuit). The transmitter **1031-1** may further include a modulator. Further, the transmitter **1031-1** may for example include a scramble unit (e.g., scrambling circuit), a modulation mapper, a layer mapper, and a layer permutator, which may be disposed before the DFT unit **1031-11**. That is, to prevent a peak-to-average power ratio (PAPR) from increasing, the transmitter **1031-1** subjects information to the DFT unit **1031-11** before mapping a signal to a subcarrier. The signal spread (or pre-coded) by the DFT unit **1031-11** is mapped onto a subcarrier by the subcarrier mapper **1031-12** and made into a signal on the time axis through the IFFT unit **1031-13**. Some of constituent elements is referred to as a unit in the disclosure. However, the embodiments are not limited thereto. For example, such term “unit” is also referred to as a circuit block, a circuit, or a circuit module.
[0213] The DFT unit **1031-11** performs DFT on input symbols to output complex-valued symbols. For example, when Ntx symbols are input (here, Ntx is a natural number), DFT has a size of Ntx. The DFT unit **1031-11** may be referred to as a transform precoder. The subcarrier mapper **1031-12** maps the complex-valued symbols onto respective subcarriers in the frequency domain. The complex-valued symbols may be mapped onto resource elements corresponding to resource blocks allocated for data transmission. The subcarrier mapper **1031-12** may be referred to as a resource element mapper. The IFFT unit **1031-13** performs IFFT on the input symbols to output a baseband signal for data as a signal in the time domain. The CP inserting unit **1031-14** copies latter part of the baseband signal for data and inserts the latter part in front of the baseband signal for data. CP insertion prevents inter-symbol interference (ISI) and inter-carrier interference (ICI), thereby maintaining orthogonality even in a multipath channel.
[0214] On the other hand, the receiver **1031-2** includes a wireless receiving unit **1031-21** (e.g., wireless receiving circuit), a CP removing unit **1031-22** (e.g., CP removing circuit), an FFT unit **1031-23** (e.g., FFT circuit), and an equalizing unit **1031-24** (e.g., equalizing circuit). The wireless receiving unit **1031-21**, the CP removing unit **1031-22**, and the FFT unit **1031-23** of the receiver **1031-2** perform reverse functions of the wireless transmitting unit **1031-15**, the CP inserting unit **1031-14**, and the IFFT unit **1031-13** of the transmitter **1031-1**. The receiver **1031-2** may further include a demodulator.
[0215] According to the embodiments of the disclosure, physical random access channel (PRACH) transmission is enabled at an earlier point than that of a UE performing a random access procedure only through a non-SBFD UL in a TDD, thereby reducing a random access (RA) delay. In addition, if switching between the non-SBFD and the SBFD is allowed during the RA procedure, an appropriate level of preamble power ramping step is applied when retransmitting the preamble based on the switching of each resource, thereby mitigating the issue of rapid power increase or decrease.
[0216] Although the preferred embodiments of the disclosure have been illustratively described, the scope of the disclosure is not limited to only the specific embodiments, and the disclosure can be modified, changed, or improved in various forms within the spirit of the disclosure and within a category written in the claim.
[0217] In the above exemplary systems, although the methods have been described in the form of a series of steps or blocks, the disclosure is not limited to the sequence of the steps, and some of the steps may be performed in different order from other or may be performed simultaneously with other steps. Further, those skilled in the art will understand that the steps shown in the flowcharts are not exclusive and may include other steps or one or more steps of the flowcharts may be deleted without affecting the scope of the disclosure.
[0218] Claims of the present disclosure may be combined in various manners. For example, technical features of the method claim of the present disclosure may be combined to implement a device, and technical features of the device claim of the present disclosure may be combined to implement a method. In addition, the technical features of the method claim and the technical features of the device claim of the present disclosure may be combined to implement a device, and technical features of the method claim and the technical features of the device claim of the present disclosure may be combined to implement a method.

Claims

1. A method of operating a user equipment (UE) in a wireless communication system, the method comprising: receiving i) configuration information for a first random access channel (RACH) resource type associated with a subband full duplex (SBFD) and ii) configuration information for a second RACH resource type associated with a non-SBFD; and setting preamble received target power based on a) a first power ramping step according to the configuration information for the first RACH resource type and b) a second power ramping step according to the configuration information for the second RACH resource type, wherein the preamble received target power is set when the RACH resource type is changed in second preamble transmission after first preamble transmission.
2. The method of claim 1, further comprising performing the second preamble transmission using the set preamble received target power.
3. The method of claim 2, wherein the second preamble transmission comprises retransmission of the first preamble transmission.
4. The method of claim 1, wherein the configuration information for the first RACH resource type comprises a first parameter associated with the first power ramping step, the configuration information for the second RACH resource type comprises a second parameter associated with the second power ramping step, and the first parameter and the second parameter are independent of each other.
5. The method of claim 1, wherein the RACH resource type corresponding to the first preamble transmission is determined at initiation of a RACH

procedure.

6. The method of claim 1, wherein: the first RACH resource type comprises a first RACH Occasion (RO) associated with the SBFD; the second RACH resource type comprises a second RO associated with the non-SBFD; and the first preamble transmission is performed through the first RO, and the second preamble transmission is performed through the second RO.

7. The method of claim 1, wherein the preamble received target power is set using a power offset calculated based on the first power ramping step and the second power ramping step.

8. A user equipment (UE) in a wireless communication system comprising: at least one processor; and at least one memory configured to store instructions and operably electrically connectable to the at least one processor, wherein operations performed based on the instructions executed by the at least one processor comprise: receiving i) configuration information for a first random access channel (RACH) resource type associated with a subband full duplex (SBFD) and ii) configuration information for a second RACH resource type associated with a non-SBFD; and setting preamble received target power based on a) a first power ramping step according to the configuration information for the first RACH resource type and b) a second power ramping step according to the configuration information for the second RACH resource type, wherein the preamble received target power is set when the RACH resource type is changed in second preamble transmission after first preamble transmission.

9. The UE of claim 8, wherein operations performed based on the instructions executed by the at least one processor further comprise: performing the second preamble transmission using the set preamble received target power.

10. The UE of claim 9, wherein the second preamble transmission comprises retransmission of the first preamble transmission.

11. The UE of claim 8, wherein; the configuration information for the first RACH resource type comprises a first parameter associated with the first power ramping step; the configuration information for the second RACH resource type comprises a second parameter associated with the second power ramping step; and the first parameter and the second parameter are independent of each other.

12. The UE of claim 8, wherein the RACH resource type corresponding to the first preamble transmission is determined at initiation of a RACH procedure.

13. The UE of claim 8, wherein: the first RACH resource type comprises a first RACH Occasion (RO) associated with the SBFD; the second RACH resource type comprises a second RO associated with the non-SBFD; and the first preamble transmission is performed through the first RO, and the second preamble transmission is performed through the second RO.

14. The UE of claim 8, wherein, the preamble received target power is set using a power offset calculated based on the first power ramping step and the second power ramping step.