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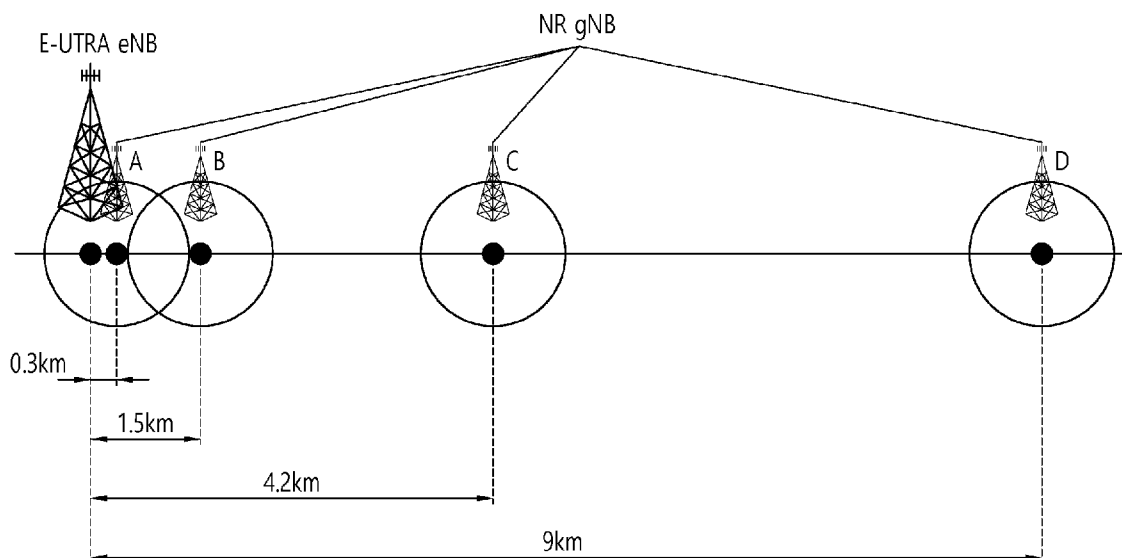
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(54) Title: METHOD FOR TRANSCIEIVING A SIGNAL AND WIRELESS TERMINAL THEREOF

(57) Abstract: A disclosure of the present specification provides a method for transceiving a signal. The method may be performed by a user equipment (UE) and comprise: transmitting uplink signals to a first cell and a second cell. The first cell and the second cell may be configured for a dual connectivity. The first cell may be an evolved universal terrestrial radio access (E-UTRA) based cell. The second cell may be a new radio access technology (NR) based cell. The method may comprise: determining that a maximum transmission timing difference (MTTD) between the first cell and the second cell is 35.21 μ s for all of uplink subcarrier spacings (SCSs) of the second cell. The all of the uplink SCSs of the second cell may include 15 kHz, 30 kHz, 60 kHz and 120 kHz.

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Description

Title of Invention: METHOD FOR TRANSCIVING A SIGNAL AND WIRELESS TERMINAL THEREOF

Technical Field

- [1] The present invention relates to mobile communication.

Background Art

- [2] With the success of Evolved Universal Terrestrial Radio Access Network (E-UTRAN) for the fourth-generation mobile communication which is Long Term Evolution (LTE)/LTE-Advanced (LTE-A), the next generation mobile communication, which is the fifth-generation (so called 5G) mobile communication, has been attracting attentions and more and more researches are being conducted.
- [3] For the fifth-generation (so called 5G) mobile communication, a new radio access technology (New RAT or NR) have been studied and researched.
- [4] An NR cell may operate not just in standalone deployment (SA), but also in a non-standalone deployment (NSA). According to the NSA deployment, a UE may be connected in dual connectivity (DC) with an E-UTRAN (that is, LTE/LTE-A) cell and the NR cell. This type of dual connectivity is called EN-DC.
- [5] However, until now, a maximum receive timing difference (MRTD) and a maximum transmission timing difference (MTTD) for EN-DC case have not been researched.

Disclosure of Invention

Technical Problem

- [6] Accordingly, a disclosure of the present specification has been made in an effort to solve the aforementioned problem.

Solution to Problem

- [7] Accordingly, in an effort to solve the aforementioned problem, a disclosure of the present specification provides a method for transceiving a signal. The method may be performed by a user equipment (UE) and comprise: transmitting uplink signals to a first cell and a second cell. The first cell and the second cell may be configured for a dual connectivity. The first cell may be an evolved universal terrestrial radio access (E-UTRA) based cell. The second cell may be a new radio access technology (NR) based cell. The method may comprise: determining that a maximum transmission timing difference (MTTD) between the first cell and the second cell is 35.21 μ s for all of uplink subcarrier spacings (SCSs) of the second cell. The all of the uplink SCSs of the second cell may include 15 kHz, 30 kHz, 60 kHz and 120 kHz.
- [8] The method may further comprise: handling the MTTD of 35.21 μ s.
- [9] The method may further comprise: receiving downlink signals from the first cell and

the second cell; and determining that a maximum receive timing difference (MRTD) between the first cell and the second cell is 33 μ s for all of downlink SCSs of the second cell. The all of the downlink SCSs of the second cell may include 15 kHz, 30 kHz, 60 kHz and 120 kHz.

[10] The method may further comprise: handling the MRTD of 33 μ s.

[11] The EN-DC may be an inter-band EN-DC.

[12] The EN-DC may be a synchronous EN-DC.

[13] Accordingly, in an effort to solve the aforementioned problem, a disclosure of the present specification provides a wireless terminal for transceiving a signal. The wireless terminal may comprise: a transceiver which transmits uplink signals to a first cell and a second cell. The first cell and the second cell may be configured for a dual connectivity. The first cell may be an evolved universal terrestrial radio access (E-UTRA) based cell. The second cell may be a new radio access technology (NR) based cell. The UE may comprise: a processor operatively connected to the transceiver and configured to determine that a maximum transmission timing difference (MTTD) between the first cell and the second cell is 35.21 μ s for all of uplink subcarrier spacings (SCSs) of the second cell. The all of the uplink SCSs of the second cell may include 15 kHz, 30 kHz, 60 kHz and 120 kHz.

[14] In an effort to solve the aforementioned problem, a disclosure of the present specification provides a controller for a wireless terminal. The controller may comprise: a processor configured to transmit, via a transceiver, uplink signals to a first cell and a second cell. The first cell and the second cell may be configured for a dual connectivity. The first cell may be an evolved universal terrestrial radio access (E-UTRA) based cell. The second cell may be a new radio access technology (NR) based cell. The processor may be configured to determine that a maximum transmission timing difference (MTTD) between the first cell and the second cell is 35.21 μ s for all of uplink subcarrier spacings (SCSs) of the second cell. The all of the uplink SCSs of the second cell may include 15 kHz, 30 kHz, 60 kHz and 120 kHz.

Advantageous Effects of Invention

[15] According to the disclosure of the present invention, the problem of the conventional technology described above may be solved.

Brief Description of Drawings

[16] FIG. 1 is a wireless communication system.

[17] FIG. 2 illustrates a structure of a radio frame according to FDD in 3GPP LTE.

[18] FIG. 3 illustrates a procedure for cell detection and measurement.

[19] FIGS. 4A to 4C are diagrams illustrating exemplary architecture for a service of the next-generation mobile communication.

- [20] FIG. 5 illustrates an example of a subframe type in NR.
- [21] FIG. 6 illustrates an example of an SS block in NR.
- [22] FIG. 7 illustrates an example of beam sweeping in NR.
- [23] FIG. 8 illustrates an example of performing measurement in an EN (E-UTRAN and NR)-DC case.
- [24] FIG. 9 shows an example of deployment of EN-DC
- [25] Fig. 10a shows an example case of $MTTD \leq T_{thr}$, Fig. 10b shows an example case of $MTTD > T_{thr}$ and Fig. 10c shows an example case of $MTTD > T_{thr}$ and $MTTD \leq T_{thr}$.
- [26] FIG. 11 is a block diagram illustrating a wireless device and a base station, by which a disclosure of this specification is implemented.
- [27] FIG. 12 is a detailed block diagram of a transceiver of the wireless device shown in FIG. 11.

Mode for the Invention

- [28] The technical terms used herein are used to merely describe specific embodiments and should not be construed as limiting the present invention. Further, the technical terms used herein should be, unless defined otherwise, interpreted as having meanings generally understood by those skilled in the art but not too broadly or too narrowly. Further, the technical terms used herein, which are determined not to exactly represent the spirit of the invention, should be replaced by or understood by such technical terms as being able to be exactly understood by those skilled in the art. Further, the general terms used herein should be interpreted in the context as defined in the dictionary, but not in an excessively narrowed manner.
- [29] The expression of the singular number in the present invention includes the meaning of the plural number unless the meaning of the singular number is definitely different from that of the plural number in the context. In the following description, the term 'include' or 'have' may represent the existence of a feature, a number, a step, an operation, a component, a part or the combination thereof described in the present invention, and may not exclude the existence or addition of another feature, another number, another step, another operation, another component, another part or the combination thereof.
- [30] The terms 'first' and 'second' are used for the purpose of explanation about various components, and the components are not limited to the terms 'first' and 'second'. 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 deviating from the scope of the present invention.
- [31] It will be understood that when an element or layer is referred to as being "connected

to" or "coupled to" another element or layer, it can be directly connected or coupled to the other element or layer or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly connected to" or "directly coupled to" another element or layer, there are no intervening elements or layers present.

[32] Hereinafter, exemplary embodiments of the present invention will be described in greater detail with reference to the accompanying drawings. In describing the present invention, for ease of understanding, the same reference numerals are used to denote the same components throughout the drawings, and repetitive description on the same components will be omitted. Detailed description on well-known arts which are determined to make the gist of the invention unclear will be omitted. The accompanying drawings are provided to merely make the spirit of the invention readily understood, but not should be intended to be limiting of the invention. It should be understood that the spirit of the invention may be expanded to its modifications, replacements or equivalents in addition to what is shown in the drawings.

[33] As used herein, 'base station' generally refers to a fixed station that communicates with a wireless device and may be denoted by other terms such as eNB (evolved-NodeB), BTS (base transceiver system), or access point.

[34] As used herein, 'user equipment (UE)' may be stationary or mobile, and may be denoted by other terms such as device, wireless device, terminal, MS (mobile station), UT (user terminal), SS (subscriber station), MT (mobile terminal) and etc.

[35] **FIG. 1 illustrates a wireless communication system.**

[36] As seen with reference to FIG. 1, the wireless communication system includes at least one base station (BS) 20. Each base station 20 provides a communication service to specific geographical areas (generally, referred to as cells) 20a, 20b, and 20c. The cell can be further divided into a plurality of areas (sectors).

[37] The UE generally belongs to one cell and the cell to which the UE belong is referred to as a serving cell. A base station that provides the communication service to the serving cell is referred to as a serving BS. Since the wireless communication system is a cellular system, another cell that neighbors to the serving cell is present. Another cell which neighbors to the serving cell is referred to a neighbor cell. A base station that provides the communication service to the neighbor cell is referred to as a neighbor BS. The serving cell and the neighbor cell are relatively decided based on the UE.

[38] Hereinafter, a downlink means communication from the base station 20 to the UE 10 and an 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.

[39] Meanwhile, the wireless communication system may be generally divided into a

frequency division duplex (FDD) type and a time division duplex (TDD) type. According to the FDD type, uplink transmission and downlink transmission are achieved while occupying different frequency bands. According to the TDD type, the uplink transmission and the downlink transmission are achieved at different time while occupying the same frequency band. A channel response of the TDD type is substantially reciprocal. This means that a downlink channel response and an uplink channel response are approximately the same as each other in a given frequency area. Accordingly, in the TDD based wireless communication system, the downlink channel response may be acquired from the uplink channel response. In the TDD type, since an entire frequency band is time-divided in the uplink transmission and the downlink transmission, the downlink transmission by the base station and the uplink transmission by the terminal may not be performed simultaneously. In the TDD system in which the uplink transmission and the downlink transmission are divided by the unit of a subframe, the uplink transmission and the downlink transmission are performed in different subframes.

[40] Hereinafter, the LTE system will be described in detail.

[41] **FIG. 2 shows a downlink radio frame structure according to FDD of 3rd generation partnership project (3GPP) long term evolution (LTE).**

[42] The radio frame of FIG. 2 may be found in the section 5 of 3GPP TS 36.211 V10.4.0 (2011-12) "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation (Release 10)".

[43] The radio frame includes 10 sub-frames indexed 0 to 9. One sub-frame includes two consecutive slots. Accordingly, the radio frame includes 20 slots. The time taken for one sub-frame to be transmitted is denoted TTI (transmission time interval). For example, the length of one sub-frame may be 1ms, and the length of one slot may be 0.5ms.

[44] The structure of the radio frame is for exemplary purposes only, and thus the number of sub-frames included in the radio frame or the number of slots included in the sub-frame may change variously.

[45] One slot includes NRB resource blocks (RBs) in the frequency domain. For example, in the LTE system, the number of resource blocks (RBs), i.e., NRB, may be one from 6 to 110.

[46] The resource block is a unit of resource allocation and includes a plurality of sub-carriers in the frequency domain. For example, if one slot includes seven OFDM symbols in the time domain and the resource block includes 12 sub-carriers in the frequency domain, one resource block may include 7x12 resource elements (REs).

[47] The physical channels in 3GPP LTE may be classified into data channels such as PDSCH (physical downlink shared channel) and PUSCH (physical uplink shared

channel) and control channels such as PDCCH (physical downlink control channel), PCFICH (physical control format indicator channel), PHICH (physical hybrid-ARQ indicator channel) and PUCCH (physical uplink control channel).

[48] The uplink channels include a PUSCH, a PUCCH, an SRS (Sounding Reference Signal), and a PRACH (physical random access channel).

[49] **<Measurement and Measurement report>**

[50] Supporting mobility of a UE 100 is essential in a mobile communication system. Thus, the UE 100 constantly measures a quality of a serving cell which is currently providing a service, and a quality of a neighbor cell. The UE 10 reports a result of the measurement to a network at an appropriate time, and the network provides optimal mobility to the UE through a handover or the like. Measurement for this purpose is referred to as a Radio Resource Management (RRM).

[51] Meanwhile, the UE 100 monitors a downlink quality of a primary cell (Pcell) based on a CRS. This is so called Radio Link Monitoring (RLM).

[52] **FIG. 3 shows a procedure for cell detection and measurement.**

[53] Referring to FIG. 3, a UE detects a neighbor cell based on Synchronization Signal (SS) which is transmitted from the neighbor cell. The SS may include a Primary Synchronization Signal (PSS) and a Secondary Synchronization Signal (SSS).

[54] When the serving cell 200a and the neighbor cell respectively transmit Cell-specific Reference Signals (CRSs), the UE 100 measures the CRSs and transmits a result of the measurement to the serving cell 200a. In this case, the UE 100 may compare power of the received CRSs based on received information on a reference signal power.

[55] At this point, the UE 100 may perform the measurement in the following three ways.

[56] 1) RSRP(reference signal received power): This represents an average reception power of all REs that carry the CRS which is transmitted through the whole bands. In this case, instead of the CRS, an average reception power of all REs that carry the CSI RS may also be measured.

[57] 2) RSS (received signal strength indicator): This represents a reception power which is measured through the whole bands. The RSSI includes all of signal, interference and thermal noise.

[58] 3) RSRQ (reference symbol received quality): This represents a CQI, and may be determined as the RSRP/RSSI according to a measured bandwidth or a sub-band. That is, the RSRQ signifies a signal-to-noise interference ratio (SINR). Since the RSRP is unable to provide a sufficient mobility, in handover or cell reselection procedure, the RSRQ may be used instead of the RSRP.

[59] The RSRQ may be obtained by RSSI/RSSP.

[60] Meanwhile, the UE 100 receives a radio resource configuration information element (IE) from the serving cell 100a for the measurement. The radio resource configuration

information element (IE) is used to configure/modify/cancel a radio bearer or to modify an MAC configuration. The radio resource configuration IE includes subframe pattern information. The subframe pattern information is information on a measurement resource restriction pattern on the time domain, for measuring RSRP and RSRQ of a serving cell (e.g., PCell).

[61] Meanwhile, the UE 100 receives a measurement configuration information element (IE) from the serving cell 100a for the measurement. A message including the measurement configuration information element (IE) is called a measurement configuration message. Here, the measurement configuration information element (IE) may be received through a RRC connection reconfiguration message. If the measurement result satisfies a report condition in the measurement configuration information, the UE reports the measurement result to a base station. A message including the measurement result is called a measurement report message.

[62] The measurement configuration IE may include measurement object information. The measurement object information is information of an object which is to be measured by the UE. The measurement object includes at least one of an intra-frequency measurement object which is an object of intra-cell measurement, an inter-frequency measurement object which is an object of inter-cell measurement and an inter-RAT measurement object which is an object of inter-RAT measurement. For example, the intra-cell measurement object indicates a neighbor cell that has a frequency band which is identical to that of a serving cell, the inter-cell measurement object indicates a neighbor cell that has a frequency band which is different from that of a serving cell, and the inter-RAT measurement object indicates a neighbor cell of a RAT which is different from that of a serving cell.

[63] [Table 1]

Measurement object field description	
carrierFreq	This indicates an E-UTRA carrier frequency to which this configuration is applied.
measCycleSCell	This indicates a cycle for measurement of a secondary cell (SCell) in a non-activated state. Its value may be set to 40, 160, 256, etc. If the value is 160, it indicates that measurement is performed every 160 subframes.

[64] Meanwhile, the measurement configuration IE includes an information element (IE) as shown in the following table.

[65] [Table 2]

MeasConfig field description
allowInterruptions If its value is True, it indicates that interruption of transmission and reception with a serving cell is allowed when measurement of subcarriers of an SCell in a non-active state is performed using MeasCycleScell.
measGapConfigIt indicates configuration or cancelation of a measurement gap.

[66] The "measGapConfig" is used to configure or cancel a measurement gap (MG). The MG is a period for cell identification and RSRP measurement on an inter frequency different from that of a serving cell.

[67] [Table 3]

MeasGapConfig field description
gapOffset Any one of gp0 and gp1 may be set as a value of gapOffset. gp0 corresponds to a gapoffset of pattern ID "0" having MGRP=40ms. gp1 corresponds to a gapoffset of pattern ID "1" having MGRP=80ms.

[68] [Table 4]

Gap pattern Id	Measurement Gap Length (MGL)	Measurement Gap Repetition Period(MGRP)	Minimum available time for inter-frequency and inter-RAT measurements during 480ms period
0	6 ms	40 ms	60 ms
1	6 ms	80 ms	30 ms

[69] When the UE requires a measurement gap to identify and measure a cell at an inter-frequency and inter-RAT, the E-UTRAN (i.e., the base station) may provide a single measurement gap (MG) pattern with a predetermined gap period to the UE. Without transmitting or receiving any data from the serving cell for the measurement gap period, the UE retunes its RF chain to be adapted to the inter-frequency and then performs measurement at the corresponding inter-frequency.

[70] <Carrier Aggregation>

[71] A carrier aggregation system is now described.

[72] A carrier aggregation system aggregates a plurality of component carriers (CCs). A meaning of an existing cell is changed according to the above carrier aggregation. According to the carrier aggregation, a cell may signify a combination of a downlink component carrier and an uplink component carrier or an independent downlink component carrier.

[73] Further, the cell in the carrier aggregation may be classified into a primary cell, a secondary cell, and a serving cell. The primary cell signifies a cell operated in a primary frequency. The primary cell signifies a cell which UE performs an initial connection establishment procedure or a connection reestablishment procedure or a cell indicated as a primary cell in a handover procedure. The secondary cell signifies a cell operating in a secondary frequency. Once the RRC connection is established, the secondary cell is used to provided an additonal radio resouce.

[74] As described above, the carrier aggregation system may support a plurality of component carriers (CCs), that is, a plurality of serving cells unlike a single carrier system.

[75] The carrier aggregation system may support a cross-carrier scheduling. The cross-carrier scheduling is a scheduling method capable of performing resource allocation of a PDSCH transmitted through other component carrier through a PDCCH transmitted through a specific component carrier and/or resource allocation of a PUSCH transmitted through other component carrier different from a component carrier basically linked with the specific component carrier.

[76] **<Introduction of Dual Connectivity (DC)>**

[77] Recently, a scheme for simultaneously connecting UE to different base stations, for example, a macro cell base station and a small cell base station, is being studied. This is called dual connectivity (DC).

[78] In DC, the eNodeB for the primary cell (Pcell) may be referred to as a master eNodeB (hereinafter referred to as MeNB). In addition, the eNodeB only for the secondary cell (Scell) may be referred to as a secondary eNodeB (hereinafter referred to as SeNB).

[79] A cell group including a primary cell (Pcell) implemented by MeNB may be referred to as a master cell group (MCG) or PUCCH cell group 1. A cell group including a secondary cell (Scell) implemented by the SeNB may be referred to as a secondary cell group (SCG) or PUCCH cell group 2.

[80] Meanwhile, among the secondary cells in the secondary cell group (SCG), a secondary cell in which the UE can transmit Uplink Control Information (UCI), or the secondary cell in which the UE can transmit a PUCCH may be referred to as a super secondary cell (Super SCell) or a primary secondary cell (Primary Scell; PScell).

[81] **<Internet of Things (IoT) Communication>**

[82] Hereinafter, IoT will be described.

[83] The IoT communication refers to the exchange of information between an IoT devices without human interaction through a base station or between the IoT device and a server through the base station. In this way, the IoT communication is also referred to as CIoT (Cellular Internet of Things) in that the IoT communication is

performed through the cellular base station.

[84] This IoT communication is a kind of machine type communication (MTC). Therefore, the IoT device may be referred to as an MTC device.

[85] The IoT communication has a small amount of transmitted data. Further, uplink or downlink data transmission/reception rarely occurs. Accordingly, it is desirable to lower a price of the IoT device and reduce battery consumption in accordance with the low data rate. In addition, since the IoT device has low mobility, the IoT device has substantially the unchanged channel environment.

[86] In one approach to a low cost of the IoT device, the IoT device may use, for example, a sub-band of approximately 1.4 MHz regardless of a system bandwidth of the cell.

[87] The IoT communication operating on such a reduced bandwidth may be called NB (Narrow Band) IoT communication or NB CIoT communication.

[88] **<Next-Generation Mobile Communication Network>**

[89] With the success of Evolved Universal Terrestrial Radio Access Network (E-UTRAN) for the fourth-generation mobile communication which is Long Term Evolution (LTE)/LTE-Advanced (LTE-A), the next generation mobile communication, which is the fifth-generation (so called 5G) mobile communication, has been attracting attentions and more and more researches are being conducted.

[90] The fifth-generation communication defined by the International Telecommunication Union (ITU) refers to providing a maximum data transmission speed of 20Gbps and a maximum transmission speed of 100Mbps per user in anywhere. It is officially called "IMT-2020" and aims to be released around the world in 2020.

[91] The ITU suggests three usage scenarios, for example, enhanced Mobile BroadBand (eMBB), massive Machine Type Communication (mMTC), and Ultra Reliable and Low Latency Communications (URLLC).

[92] URLLC relates to a usage scenario in which high reliability and low delay time are required. For example, services like autonomous driving, automation, and virtual realities requires high reliability and low delay time (for example, 1ms or less). A delay time of the current 4G (LTE) is statistically 21-43ms (best 10%), 33-75ms (median). Thus, the current 4G (LTE) is not sufficient to support a service requiring a delay time of 1ms or less. Next, eMBB relates to a usage scenario in which an enhanced mobile broadband is required.

[93] That is, the fifth-generation mobile communication system aims to achieve a capacity higher than the current 4G LTE and is capable of increasing a density of mobile broadband users and support Device-to-Device (D2D), high stability, and Machine Type Communication (MTC). Researches on 5G aims to achieve reduced waiting time and less batter consumption, compared to a 4G mobile communication system, in order to implement the IoT. For the 5G mobile communication, a new radio access

technology (New RAT or NR) may be proposed.

[94] **FIGS. 4A to 4C are diagrams illustrating exemplary architecture for a next-generation mobile communication service.**

[95] Referring to FIG. 4A, a UE is connected in dual connectivity (DC) with an LTE/LTE-A cell and a NR cell.

[96] The NR cell is connected with a core network for the legacy fourth-generation mobile communication, that is, an Evolved Packet core (EPC).

[97] Referring to FIG. 4B, the LTE/LTE-A cell is connected with a core network for 5th generation mobile communication, that is, a Next Generation (NG) core network, unlike the example in FIG. 4A.

[98] A service based on the architecture shown in FIGS. 4A and 4B is referred to as a non-standalone (NSA) service.

[99] Referring to FIG. 4, a UE is connected only with an NR cell. A service based on this architecture is referred to as a standalone (SA) service.

[100] Meanwhile, in the above new radio access technology (NR), using a downlink subframe for reception from a base station and using an uplink subframe for transmission to the base station may be considered. This method may be applied to paired spectrums and not-paired spectrums. A pair of spectrum indicates including two subcarrier for downlink and uplink operations. For example, one subcarrier in one pair of spectrum may include a pair of a downlink band and an uplink band.

[101] **FIG. 5 shows an example of subframe type in NR.**

[102] A transmission time interval (TTI) shown in FIG. 5 may be called a subframe or slot for NR (or new RAT). The subframe (or slot) in FIG. 5 may be used in a TDD system of NR (or new RAT) to minimize data transmission delay. As shown in FIG. 4, a subframe (or slot) includes 14 symbols as does the current subframe. A front symbol of the subframe (or slot) may be used for a downlink control channel, and a rear symbol of the subframe (or slot) may be used for an uplink control channel. Other channels may be used for downlink data transmission or uplink data transmission. According to such structure of a subframe (or slot), downlink transmission and uplink transmission may be performed sequentially in one subframe (or slot). Therefore, a downlink data may be received in the subframe (or slot), and an uplink acknowledge response (ACK/NACK) may be transmitted in the subframe (or slot). A subframe (or slot) in this structure may be called a self-contained subframe. If this structure of a subframe (or slot) is used, it may reduce time required to retransmit data regarding which a reception error occurred, and thus, a final data transmission waiting time may be minimized. In such structure of the self-contained subframe (slot), a time gap may be required for transition from a transmission mode to a reception mode or vice versa. To this end, when downlink is transitioned to uplink in the subframe structure, some

OFDM symbols may be set as a Guard Period (GP).

[103] **<Support of Various Numerologies>**

[104] In the next generation system, with development of wireless communication technologies, a plurality of numerologies may be provided to a UE.

[105] The numerologies may be defined by a length of cycle prefix (CP) and a subcarrier spacing. One cell may provide a plurality of numerology to a UE. When an index of a numerology is represented by μ , a subcarrier spacing and a corresponding CP length may be expressed as shown in the following table.

[106] [Table 5]

μ	$f=2^{\mu}15$ [kHz]	CP
0	15	Normal
1	30	Normal
2	60	Normal, Extended
3	120	Normal
4	240	Normal

[107] In the case of a normal CP, when an index of a numerology is expressed by μ , the number of OFDM symbols per slot $N_{\text{slot}}^{\text{slot}}$, the number of slots per frame $N_{\text{frame},\mu\text{slot}}$, and the number of slots per subframe $N_{\text{subframe},\mu\text{slot}}$ are expressed as shown in the following table.

[108] [Table 6]

μ	$N_{\text{slot}}^{\text{slot}}$	$N_{\text{frame},\mu\text{slot}}$	$N_{\text{subframe},\mu\text{slot}}$
0	14	10	1
1	14	20	2
2	14	40	4
3	14	80	8
4	14	160	16
5	14	320	32

[109] In the case of an extended CP, when an index of a numerology is represented by μ , the number of OFDM symbols per slot $N_{\text{slot}}^{\text{slot}}$, the number of slots per frame $N_{\text{frame},\mu\text{slot}}$, and the number of slots per subframe $N_{\text{subframe},\mu\text{slot}}$ are expressed as shown in the following table.

[110] [Table 7]

μ	$N_{\text{slot}}^{\text{symb}}$	$N_{\text{frame}, \mu}^{\text{slot}}$	$N_{\text{subframe}, \mu}^{\text{slot}}$
2	12	40	4

[111] Meanwhile, in the next-generation mobile communication, each symbol may be used for downlink or uplink, as shown in the following table. In the following table, uplink is indicated by U, and downlink is indicated by D. In the following table, X indicates a symbol that can be flexibly used for uplink or downlink.

[112] [Table 8]

[illegible]

28	D	D	D	D	D	D	D	D	D	D	D	D	X	U
29	D	D	D	D	D	D	D	D	D	D	D	X	X	U
30	D	D	D	D	D	D	D	D	D	D	X	X	X	U
31	D	D	D	D	D	D	D	D	D	D	D	X	U	U
32	D	D	D	D	D	D	D	D	D	D	X	X	U	U
33	D	D	D	D	D	D	D	D	D	X	X	X	U	U
34	D	X	U	U	U	U	U	U	U	U	U	U	U	U
35	D	D	X	U	U	U	U	U	U	U	U	U	U	U
36	D	D	D	X	U	U	U	U	U	U	U	U	U	U
37	D	X	X	U	U	U	U	U	U	U	U	U	U	U
38	D	D	X	X	U	U	U	U	U	U	U	U	U	U
39	D	D	D	X	X	U	U	U	U	U	U	U	U	U
40	D	X	X	X	U	U	U	U	U	U	U	U	U	U
41	D	D	X	X	X	U	U	U	U	U	U	U	U	U
42	D	D	D	X	X	X	U	U	U	U	U	U	U	U
43	D	D	D	D	D	D	D	D	D	X	X	X	X	U
44	D	D	D	D	D	D	X	X	X	X	X	X	U	U
45	D	D	D	D	D	D	X	X	U	U	U	U	U	U
46	D	D	D	D	D	D	X	D	D	D	D	D	D	X
47	D	D	D	D	D	X	X	D	D	D	D	D	X	X
48	D	D	X	X	X	X	X	D	D	X	X	X	X	X
49	D	X	X	X	X	X	X	D	X	X	X	X	X	X
50	X	U	U	U	U	U	U	X	U	U	U	U	U	U
51	X	X	U	U	U	U	U	X	X	U	U	U	U	U
52	X	X	X	U	U	U	U	X	X	X	U	U	U	U
53	X	X	X	X	U	U	U	X	X	X	X	U	U	U
54	D	D	D	D	D	X	U	D	D	D	D	D	X	U
55	D	D	X	U	U	U	U	D	D	X	U	U	U	U
56	D	X	U	U	U	U	U	D	X	U	U	U	U	U
57	D	D	D	D	X	X	U	D	D	D	D	X	X	U
58	D	D	X	X	U	U	U	D	D	X	X	U	U	U

59	D	X	X	U	U	U	U	D	X	X	U	U	U	U
60	D	X	X	X	X	X	U	D	X	X	X	X	X	U
61	D	D	X	X	X	X	U	D	D	X	X	X	X	U

[113] **<Operating Band in NR>**

[114] An operating band in NR is as follows.

[115] An operating band shown in Table 9 is a reframing operating band that is transitioned from an operating band of LTE/LTE-A. This operating band is referred to as FR1 band.

[116] [Table 9]

NR Operating Band	Uplink Operating Band	Downlink Operating Band	Duplex Mode
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	
n1	1920 MHz - 1980 MHz	2110 MHz - 2170 MHz	FDD
n2	1850 MHz - 1910 MHz	1930 MHz - 1990 MHz	FDD
n3	1710 MHz - 1785 MHz	1805 MHz - 1880 MHz	FDD
n5	824 MHz - 849 MHz	869 MHz - 894 MHz	FDD
n7	2500 MHz - 2570 MHz	2620 MHz - 2690 MHz	FDD
n8	880 MHz - 915 MHz	925 MHz - 960 MHz	FDD
n20	832 MHz - 862 MHz	791 MHz - 821 MHz	FDD
n28	703 MHz - 748 MHz	758 MHz - 803 MHz	FDD
n38	2570 MHz - 2620 MHz	2570 MHz - 2620 MHz	TDD
n41	2496 MHz - 2690 MHz	2496 MHz - 2690 MHz	TDD
n50	1432 MHz - 1517 MHz	1432 MHz - 1517 MHz	TDD
n51	1427 MHz - 1432 MHz	1427 MHz - 1432 MHz	TDD
n66	1710 MHz - 1780 MHz	2110 MHz - 2200 MHz	FDD
n70	1695 MHz - 1710 MHz	1995 MHz - 2020 MHz	FDD
n71	663 MHz - 698 MHz	617 MHz - 652 MHz	FDD
n74	1427 MHz - 1470 MHz	1475 MHz - 1518 MHz	FDD
n75	N/A	1432 MHz - 1517 MHz	SDL
n76	N/A	1427 MHz - 1432 MHz	SDL
n77	3300 MHz - 4200 MHz	3300 MHz - 4200 MHz	TDD
n78	3300 MHz - 3800 MHz	3300 MHz - 3800 MHz	TDD
n79	4400 MHz - 5000 MHz	4400 MHz - 5000 MHz	TDD
n80	1710 MHz - 1785 MHz	N/A	SUL
n81	880 MHz - 915 MHz	N/A	SUL
n82	832 MHz - 862 MHz	N/A	SUL
n83	703 MHz - 748 MHz	N/A	SUL
n84	1920 MHz - 1980 MHz	N/A	SUL

[117] The following table shows an NR operating band defined at high frequencies. This

operating band is referred to as FR2 band.

[118] [Table 10]

NR Operating Band	Uplink Operating Band	Downlink Operating Band	Duplex Mode
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	
n257	26500 MHz - 29500 MHz	26500 MHz - 29500 MHz	TDD
n258	24250 MHz - 27500 MHz	24250 MHz - 27500 MHz	TDD
n259	37000 MHz - 40000 MHz	37000 MHz - 40000 MHz	TDD
n260	27500MHz - 28350MHz	27500MHz - 28350MHz	TDD

[119] Meanwhile, when the operating band shown in the above table is used, a channel bandwidth is used as shown in the following table.

[120] [Table 11]

SCS (kHz)	5MHz	10MHz	15MHz	20MHz	25MHz	30MHz	40MHz	50MHz	60MHz	80MHz	100MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}
15	25	52	79	106	133	[160]	216	270	N/A	N/A	N/A
30	11	24	38	51	65	[78]	106	133	162	217	273
60	N/A	11	18	24	31	[38]	51	65	79	107	135

[121] In the above table, SCS indicates a subcarrier spacing. In the above table, N_{RB} indicates the number of RBs.

[122] Meanwhile, when the operating band shown in the above table is used, a channel bandwidth is used as shown in the following table.

[123] [Table 12]

SCS (kHz)	50MHz	100MHz	200MHz	400 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}
60	66	132	264	N.A
120	32	66	132	264

[124] **<SS block in NR>**

[125] In the 5G NR, information required for a UE to perform an initial access, that is, a Physical Broadcast Channel (PBCH) including a Master Information Block (MIB) and a synchronization signal (SS) (including PSS and SSS) are defined as an SS block. In

addition, a plurality of SS blocks may be grouped and defined as an SS burst, and a plurality of SS bursts may be grouped and defined as an SS burst set. It is assumed that each SS block is beamformed in a particular direction, and various SS blocks existing in an SS burst set are designed to support UEs existing in different directions.

[126] **FIG. 6 is a diagram illustrating an example of an SS block in NR.**

[127] Referring to FIG. 6, an SS burst is transmitted in every predetermined periodicity. Accordingly, a UE receives SS blocks, and performs cell detection and measurement.

[128] Meanwhile, in the 5G NR, beam sweeping is performed on an SS. A detailed description thereof will be provided with reference to FIG. 7.

[129] **FIG. 7 is a diagram illustrating an example of beam sweeping in the NR.**

[130] A base station transmits each SS block in an SS burst over time while performing beam sweeping. In this case, multiple SS blocks in an SS burst set are transmitted to support UEs existing in different directions. In FIG. 6, the SS burst set includes one to six SS blocks, and each SS burst includes two SS blocks.

[131] **<Channel Raster and Sync Raster>**

[132] Hereinafter, a channel raster and a sync raster will be described.

[133] A frequency channel raster is defined as a set of RF reference frequencies (FREF). An RF reference frequency may be used as a signal indicative of locations of an RF channel, an SS block, and the like.

[134] A global frequency raster may be defined with respect to all frequencies from 0 GHz to 100 GHz. The granularity of the global frequency raster may be expressed by ΔF_{Global} .

[135] An RF reference frequency is designated by NR Absolute Radio Frequency Channel Number (NR-AFRCN) in the global frequency raster's range (0 .. 2016666). A relationship between the NR-AFRCN and the RF reference frequency (FREF) of MHz may be expressed as shown in the following equation. Here, FREF-Offs and NRef-Offs are expressed as shown in the following Table.

[136] [Math.1]

$$F_{\text{REF}} = F_{\text{REF-Offs}} + \Delta F_{\text{Global}} (N_{\text{REF}} - N_{\text{REF-Offs}})$$

[137] [Table 13]

Frequency Range (MHz)	ΔF_{Global} (kHz)	$F_{\text{REF-Offs}}$ (MHz)	$N_{\text{REF-Offs}}$	Range of N_{REF}
0 - 3000	5	0	0	0 - 599999
3000 - 24250	15	3000	600000	600000 - 2016666
24250-100000	60	24250.08	2016667	2016667 - 3279165

- [138] A channel raster indicates a subset of FR reference frequencies able to be used to identify location of an RF channel in uplink and downlink. An RF reference frequency for an RF channel may be mapped to a resource element on a subcarrier.
- [139] Mapping of the RF reference frequency of the channel raster and the corresponding resource element may be used to identify a location of an RF channel. The mapping may differ according to a total number of RBs allocated to the channel, and the mapping applies to both uplink (UL) and downlink (DL).
- [140] When $N_{RB} \bmod 2 = 0$,
- [141] the RE index k is 0, and
- [142] the number of PRBs is as below.
- [143]
$$n_{PRB} = \left\lfloor \frac{N_{RB}}{2} \right\rfloor$$
- [144] Locations of RF channels of a channel raster in each NR operating band may be expressed as shown in the following table.

[145] [Table 14]

NR Operating Band	ΔF_{Raster} (kHz)	Uplink Frequency Range of N_{REF} (First - <Step size> - Last)	Uplink Frequency Range of N_{REF} (First - <Step size> - Last)
n1	100	384000 - <20> - 396000	422000 - <20> - 434000
n2	100	370000 - <20> - 382000	386000 - <20> - 398000
n3	100	342000 - <20> - 357000	361000 - <20> - 376000
n5	100	164800 - <20> - 169800	173800 - <20> - 178800
n7	100	500000 - <20> - 514000	524000 - <20> - 538000
n8	100	176000 - <20> - 183000	185000 - <20> - 192000
n12	100	139800 - <20> - 143200	145800 - <20> - 149200
n20	100	166400 - <20> - 172400	158200 - <20> - 164200
n25	100	370000 - <20> - 383000	386000 - <20> - 399000
n28	100	140600 - <20> - 149600	151600 - <20> - 160600
n34	100	402000 - <20> - 405000	402000 - <20> - 405000
n38	100	514000 - <20> - 524000	514000 - <20> - 524000
n39	100	376000 - <20> - 384000	376000 - <20> - 384000
n40	100	460000 - <20> - 480000	460000 - <20> - 480000
n41	15	499200 - <3> - 537999	499200 - <3> - 537999
	30	499200 - <6> - 537996	499200 - <6> - 537996
n51	100	285400 - <20> - 286400	285400 - <20> - 286400
n66	100	342000 - <20> - 356000	422000 - <20> - 440000
n70	100	339000 - <20> - 342000	399000 - <20> - 404000
n71	100	132600 - <20> - 139600	123400 - <20> - 130400
n75	100	N/A	286400 - <20> - 303400
n76	100	N/A	285400 - <20> - 286400
n77	15	620000 - <1> - 680000	620000 - <1> - 680000
	30	620000 - <2> - 680000	620000 - <2> - 680000
n78	15	620000 - <1> - 653333	620000 - <1> - 653333
	30	620000 - <2> - 653332	620000 - <2> - 653332

n79	15	693334 - <1> - 733333	693334 - <1> - 733333
	30	693334 - <2> - 733332	693334 - <2> - 733332
n80	100	342000 - <20> - 357000	N/A
n81	100	176000 - <20> - 183000	N/A
n82	100	166400 - <20> - 172400	N/A
n83	100	140600 - <20> - 149600	N/A
n84	100	384000 - <20> - 396000	N/A
n86	100	342000 - <20> - 356000	N/A

[146] [Table 15]

NR Operating Band	ΔF_{Raster} (kHz)	Uplink and Downlink Frequency Range(First - <Step size> - Last)
n257	60	2054166 - <1> - 2104165
	120	2054167 - <2> - 2104165
n258	60	2016667 - <1> - 2070832
	120	2016667 - <2> - 2070831
n260	60	2229166 - <1> - 2279165
	120	2229167 - <2> - 2279165
n261	60	2070833 - <1> - 2084999
	120	2070833 - <2> - 2087497

[147] Meanwhile, a sync raster indicates a frequency location of an SS block used by a UE to acquire system information. The frequency location of the SS block may be defined as SSREF using a GSCN number corresponding thereto

[148] **FIG. 8 shows an example of performing measurement in E-UTRAN and NR (EN) DC case.**

[149] Referring to FIG. 8, the UE 100 are connected in EN-DC with an E-UTRAN (that is, LTE/LTE-A) cell. Here, a Pcell in EN-DC may be an E-UTRAN (that is, LTE/LTE-A) cell, and a PSCell in EN-DC may be an NR cell.

[150] The UE 100 may receive measurement configuration (or "measconfig") information element (IE) of the E-UTRAN (that is, LTE/LTE-A) cell. The measurement configuration (or "measconfig") IE received from the E-UTRAN (that is, LTE/LTE-A) cell may further include fields shown in the following table, in addition to the fields shown in Table 2.

[151] [Table 16]

MeasConfig field description
fr1-Gap This field exists when a UE is configured with EN-DC. This field indicates whether a gap is applied to perform measurement on FR1 band (that is, a band shown in Table 9).
mgta It indicates whether to apply a timing advance (TA) of 0.5ms for a measurement gap configuration provided by the E-UTRAN.

[152] The measurement configuration (or "measconfig") IE may further include a meas-GapConfig field for setting a measurement gap (MG), as shown in Table 2. A gapoffset field within the measGapConfig field may further include gp4, gp5, gp_{11} for EN-DC, in addition to the example shown in Table 3.

[153] Meanwhile, the UE 100 may receive a measurement configuration ("measconfig") IE of an NR cell, which is a PSCell, directly from the NR cell or through the E-UTRAN cell which is a Pcell.

[154] Meanwhile, the measurement configuration ("measconfig") IE of the NR cell may include fields as shown in the following table.

[155] [Table 17]

MeasConfig field description
measGapConfig It indicates configuration or cancelation of a measurement gap
s-MeasureConfig It indicates a threshold value for measurement of NR SpCell RSRP when a UE needs to perform measurement on a non-serving cell.

[156] The above measGapConfig may further include fields as shown in the following table.

[157] [Table 18]

MeasGapConfig field description
gapFR2 It indicates a measurement gap configuration applicable for FR2 frequency range.
gapOffset It indicates a gap offset of a gap pattern with an MGRP.
mg It indicates a measurement gap length by ms. There may be 3ms, 4ms, 6ms, etc.
mgrp It indicates a measurement gap repetition period by ms.
mgta It indicates whether to apply a timing advance (TA) of 0,5ms for a measurement gap configuration.

[158] Meanwhile, as shown in the drawing, the UE 100 receives a radio resource con-

figuration information element (IE) of the E-UTRAN (that is, LTE/LTE-A) cell which is a Pcell. In addition, the UE may receive a radio resource configuration IE of an NR cell, which is a PSCell, from the NR cell or through the E-UTRAN cell which is a Pcell. The radio resource configuration IE includes subframe pattern information, as described above with reference to FIG. 3. The UE 100 performs measurement and reports a measurement result. Specifically, the UE 100 interrupts data transmission and reception with the E-UTRAN (that is, LTE/LTE-A) cell during the measurement gap, retunes its own RF chain, and performs measurement based on receipt of an SS block from an NR cell.

[159] **<Disclosure of the Present Specification>**

[160] **I. First Disclosure**

[161] The first disclosure provides a behavior and/or requirement of a wireless device related to a maximum receive timing difference (MRTD) and a maximum transmission timing difference (MTTD) in an inter-band synchronous case and EN DC case.

[162] For inter-band synchronous EN-DC, the MRTD and the MTTD have not been researched for higher SCS such as 30kHz, 60kHz and 120kHz. For the MRTD and MTTD, a network deployment scenarios, a power control related UE implementation and a timing alignment error (TAE) between inter-band NR CA should be considered.

[163] A. Network deployment scenarios.

[164] LTE network deployment is not changed due to EN-DC and is kept. If NR network is deployed for EN-DC, a propagation delay difference between a E-UTRA based eNB to UE and a NR based gNB to UE is not dependent of NS SCS. For example of agreed MRTD of 33us for NR SCS of 15kHz, 30us is propagation delay difference and 3us is TAE (timing alignment error) between eNB (E-UTRA) and gNB (NR). The propagation delay difference of 30us is not changed due to NR SCS of 30kHz, 60kHz and 120kHz. However, it does not mean that the propagation delay difference can be used to define MRTD for higher NR SCS.

[165] B. Power control related UE implementation

[166] One half NR OFDM symbol needs to be considered for the MRTD and MTTD in aspect of UE implementation related to power control and AGC. Below table shows the one half NR OFDM symbol duration.

[167] [Table 19]

NR SCS(kHz)	15	30	60	120
OFDM symbol duration(us)	66.67	33.33	16.67	8.33
CP duration(us)	4.69	2.34	1.17	0.57
OFDM symbol including CP(us)	71.35	35.68	17.84	8.92
OFDM one half symbol duration(us)	33.33	16.67	8.33	4.17

[168] C. TAE between inter-band NR CAThe TAE does not exceed [3 μ s] for inter-band NR CA. The TAE can be considered for the MRTD and MTTD.

[169] Regarding three aspects above, one half symbol corresponding NR SCS can be interpreted if it divides propagation delay difference and TAE according to whether to consider UE complexity of implementation or not as follows. Below table shows a MRTD for inter-band synchronous EN-DC.

[170] [Table 20]

	considering UE complexity				not considering UE complexity			
NR SCS(kHz)	15	30	60	120	15	30	60	120
MRTD (us)	33	17	8	4	33	33	33	33
Propagation delay difference(us)/(distance difference(km))	30(9km)	14(4.2km)	5(1.5km)	1(0.3km)	30(9km)	30(9km)	30(9km)	30(9km)
TAE(us)	3	3	3	3	3	3	3	3

[171] The main different thing for MRTD by UE complexity is to limit inter-band synchronous EN-DC operation depending on UE location and deployed NR gNB location within E-UTRA eNB coverage at higher NR SCS.

[172] **FIG. 9 shows an example of deployment of EN-DC.**

[173] 4 different NR gNBs are assumed to be deployed with distance of 0.3km, 1.5km, 4.2km and 9km from E-UTRA eNB. Depending on with or without considering UE complexity of implementation, inter-band synchronous EN-DC or inter-band asynchronous EN-DC can be divided according to NR SCS for the UE which is served from NR gNB, such as A, B, C and D as below table. The below table shows possible

inter-band synchronous EN-DC according to NR SCS in UE side.

[174] [Table 21]

considering UE complexity				
NR SCS(kHz)	A(~0.3km)	B(0.3~1.5km)	C(1.5~4.2km)	D(4.2~9km)
15	Sync.	Sync.	Sync.	Sync.
30	Sync.	Sync.	Sync.	Async.
60	Sync.	Sync.	Async.	Async.
120	Sync.	Async.	Async.	Async.
not considering UE complexity				
NR SCS(kHz)	A(~0.3km)	B(0.3~1.5km)	C(1.5~4.2km)	D(4.2~9km)
15	Sync.	Sync.	Sync.	Sync.
30				
60				
120				

[175] As shown in the above table, inter-band synchronous EN-DC operation in UE side is very limited when considering UE complexity. On the other hand, in case of not considering UE complexity inter-band synchronous EN-DC operation in UE side is not limited and is regardless of NR SCS. It can give significant impact in aspect of NW operation and UE applicability related to synchronous EN-DC. Therefore, it is desirable to specify the separate MRTD and MTTD requirement for the limited inter-band synchronous EN-DC and the non-limited inter-band synchronous EN-DC from UE side. And, UE capability is needed to differentiate the limited inter-band synchronous EN-DC and the non-limited inter-band synchronous EN-DC in UE side.

[176] Proposal 1: For inter-band synchronous EN-DC, define a separate MRTD and MTTD for inter-band synchronous EN-DC based on UE capability of complexity of implementation.

[177] Proposal 1a: UE capability is needed to differentiate a limited inter-band synchronous EN-DC and a non-limited inter-band synchronous EN-DC from UE side based on UE complexity of implementation.

[178] Proposal 2: For inter-band synchronous EN-DC with considering UE complexity of implementation, MRTD is proposed with 17us, 8us and 4us for DL NR SCS of 30kHz, 60kHz and 120kHz respectively in addition to 33us corresponding to DL NR SCS of

15kHz.

[179] Proposal 3: For inter-band synchronous EN-DC without considering UE complexity of implementation, MRTD is proposed with 33us for all DL NR SCSs. Here, all DL SCSs include 15 kHz, 30 kHz, 60 kHz and 120 kHz. That is, MRTD is proposed with 33us regardless of whether DL SCS is 15 kHz, 30 kHz, 60 kHz or 120 kHz. Here, as above explained, EN-DC means that a first cell and a second cell are configured for dual connectivity. And, the first cell is an E-UTRA based cell and the second cell is a NR based cell. The first cell is a primary cell and the second cell is a secondary cell.

[180] For MTTD, it is interpreted with MRTD + (transmission timing error + uncertainty of receiving time). Therefore, transmission timing error and uncertainty of receiving time for both E-UTRA and NR need to be identified. For E-UTRA, transmission timing error of 24Ts and uncertainty of 10Ts can be reused.

[181] For NR, NR transmission timing error was already agreed as the below table. Here, 1Ts = 64Tc. Below table shows Te (Timing Error) Limit

[182] [Table 22]

Frequency Range	SCS of SSB signals (KHz)	SCS of uplink signals s(KHz)	Te
FR1	15	15	[12]*64*Tc
		30	[10]*64*Tc
		60	[10]*64*Tc
	30	15	[8]*64*Tc
		30	[8]*64*Tc
		60	[7]*64*Tc
FR2	120	60	[3.5]*64*Tc
		120	[3.5]*64*Tc
	240	60	[3]*64*Tc
		120	[3]*64*Tc

[183] Tc is the basic timing unit(eg. $T_c = 1/(480000 \cdot 4096)$ second). For NR, based on 10Ts in E-UTRA, we scales the value with 1, 1/2, 1/4 and 1/8 for NR SCS as the below table. The below table shows T_u (Uncertainty of receiving time in PSCell)

[184] [Table 23]

DL Sub-carrier spacing in PSCell (kHz)	Tu: uncertainty of receiving time (Ts)
15	10
30	5
60	2.5
120	1.25

[185] The above table shows the total transmission timing error and uncertainty of receiving time for FR1 and FR2. The calculated total transmission timing error and uncertainty are from 1.50us to 1.82us in FR1 and from 1.25us to 1.30us in FR2. It seems small difference for FR1 and FR2. Regarding small difference among the calculated values, one value for FR1 and one value for FR2 seem to be desirable for simplicity.

[186] The below table shows a total transmission timing error and uncertainty of receiving time.

[187] [Table 24]

Freq.R ange	SCS of SSB (KHz)	SCS of DL (KHz)	SCS of UL (KHz)	Total transmission timing error and un- certainty of receiving time (us)	Te in PCell	Te in PSCell	Tu in PCell	Tu in PSCell
FR1	15	15	15	1.82	$24 \cdot T_s$	$[12] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		15	30	1.76	$24 \cdot T_s$	$[10] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		15	60	1.76	$24 \cdot T_s$	$[10] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		30	15	1.82	$24 \cdot T_s$	$[12] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		30	30	1.76	$24 \cdot T_s$	$[10] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		30	60	1.76	$24 \cdot T_s$	$[10] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		60	15	1.82	$24 \cdot T_s$	$[12] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		60	30	1.76	$24 \cdot T_s$	$[10] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		60	60	1.76	$24 \cdot T_s$	$[10] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
	30	15	15	1.69	$24 \cdot T_s$	$[8] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		15	30	1.69	$24 \cdot T_s$	$[8] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		15	60	1.66	$24 \cdot T_s$	$[7] \cdot T_s$	$10 \cdot T_s$	$[10] \cdot T_s$
		30	15	1.53	$24 \cdot T_s$	$[8] \cdot T_s$	$10 \cdot T_s$	$[5] \cdot T_s$
		30	30	1.53	$24 \cdot T_s$	$[8] \cdot T_s$	$10 \cdot T_s$	$[5] \cdot T_s$
		30	60	1.50	$24 \cdot T_s$	$[7] \cdot T_s$	$10 \cdot T_s$	$[5] \cdot T_s$
		60	15	1.53	$24 \cdot T_s$	$[8] \cdot T_s$	$10 \cdot T_s$	$[5] \cdot T_s$
		60	30	1.53	$24 \cdot T_s$	$[8] \cdot T_s$	$10 \cdot T_s$	$[5] \cdot T_s$
		60	60	1.50	$24 \cdot T_s$	$[7] \cdot T_s$	$10 \cdot T_s$	$[5] \cdot T_s$

FR2	120	60	60	1.30	$24 * T_s$	$[3.5] * T_s$	$10 * T_s$	$[2.5] * T_s$
		60	120	1.30	$24 * T_s$	$[3.5] * T_s$	$10 * T_s$	$[2.5] * T_s$
		120	60	1.26	$24 * T_s$	$[3.5] * T_s$	$10 * T_s$	$[1.25] * T_s$
		120	120	1.26	$24 * T_s$	$[3.5] * T_s$	$10 * T_s$	$[1.25] * T_s$
	240	60	60	1.29	$24 * T_s$	$[3] * T_s$	$10 * T_s$	$[2.5] * T_s$
		60	120	1.29	$24 * T_s$	$[3] * T_s$	$10 * T_s$	$[2.5] * T_s$
		120	60	1.25	$24 * T_s$	$[3] * T_s$	$10 * T_s$	$[1.25] * T_s$
		120	120	1.25	$24 * T_s$	$[3] * T_s$	$10 * T_s$	$[1.25] * T_s$

- [188] MTTD of $35.21\mu s (=33\mu s(\text{MRTD})+2.21\mu s)$ was agreed for NR SCS of 15kHz. Here, $2.21\mu s$ was assumed for the total transmission timing error and uncertainty of receiving time. Comparing with the calculated $1.82\mu s$ in the below table, about $0.4\mu s$ is considered as margin.. With the margin of $0.4\mu s$, our preferable value is $2.21\mu s$ for FR1 and $1.7\mu s$ for FR2 for the total transmission timing error and uncertainty of receiving time. Another preference is $2.21\mu s$ for both FR1(Sub6GHz) and FR2(mmWave).The below table shows the calculated MTTD for inter-band synchronous EN-DC with $2.21\mu s$ for FR1 and $1.7\mu s$ for FR2.

[189] [Table 25]

Freq. Range	SCS of SSB (KHz)	SCS of DL (KHz)	SCS of UL (KHz)	Total transmission timing error and uncertainty of receiving time (us)	MRTD with considering UE complexity of implementation(us)	MRTD without considering UE complexity of implementation(us)	MTTD with considering UE complexity of implementation(us)	MTTD without considering UE complexity of implementation(us)
FR1	15	15	15	2.21	33	33	35.21	35.21
		15	30	2.21	33	33	35.21	35.21
		15	60	2.21	33	33	35.21	35.21
		30	15	2.21	33	33	35.21	35.21
		30	30	2.21	33	33	35.21	35.21
		30	60	2.21	33	33	35.21	35.21
		60	15	2.21	33	33	35.21	35.21
		60	30	2.21	33	33	35.21	35.21
		60	60	2.21	33	33	35.21	35.21
	30	15	15	2.21	33	33	35.21	35.21
		15	30	2.21	33	33	35.21	35.21
		15	60	2.21	33	33	35.21	35.21
		30	15	2.21	17	33	19.21	35.21
		30	30	2.21	17	33	19.21	35.21
		30	60	2.21	17	33	19.21	35.21
		60	15	2.21	17	33	19.21	35.21
		60	30	2.21	17	33	19.21	35.21
		60	60	2.21	17	33	19.21	35.21

FR2	120	60	60	1.70	8	33	9.7	34.7
		60	120	1.70	8	33	9.7	34.7
		120	60	1.70	4	33	5.7	34.7
		120	120	1.70	4	33	5.7	34.7
	240	60	60	1.70	8	33	9.7	34.7
		60	120	1.70	8	33	9.7	34.7
		120	60	1.70	4	33	5.7	34.7
		120	120	1.70	4	33	5.7	34.7

[190] From the the above table, the present specification proposes MTTD for inter-band synchronous EN-DC.

[191] Proposal 4: For inter-band synchronous EN-DC with considering UE complexity of implementation, MTTD is proposed with 19.21us, 9.7us and 5.7us for DL NR SCS of 30kHz, 60kHz and 120kHz respectively in addition to 35.21us corresponding to DL NR SCS of 15kHz.

[192] Proposal5: For inter-band synchronous EN-DC without considering UE complexity of implementation, MTTD is proposed with 35.21us for DL NR SCS of 15kHz and 30kHz, and 34.7us for DL NR SCS of 60kHz and 120kHz.

[193] The below table shows the calculated MTTD for inter-band synchronous EN-DC with 2.21us for both FR1 and FR2.

[194] [Table 26]

Freq. Range	SCS of SSB (KHz)	SCS of DL (KHz)	SCS of UL (KHz)	Total transmission timing error and uncertainty of receiving time (us)	MRTD with considering UE complexity of implementation(us)	MRTD without considering UE complexity of implementation(us)	MTTD with considering UE complexity of implementation(us)	MTTD without considering UE complexity of implementation(us)
1	15	15	15	2.21	33	33	35.21	35.21
		15	30	2.21	33	33	35.21	35.21
		15	60	2.21	33	33	35.21	35.21
		30	15	2.21	33	33	35.21	35.21
		30	30	2.21	33	33	35.21	35.21
		30	60	2.21	33	33	35.21	35.21
		60	15	2.21	33	33	35.21	35.21
		60	30	2.21	33	33	35.21	35.21
		60	60	2.21	33	33	35.21	35.21
	30	15	15	2.21	33	33	35.21	35.21
		15	30	2.21	33	33	35.21	35.21
		15	60	2.21	33	33	35.21	35.21
		30	15	2.21	17	33	19.21	35.21
		30	30	2.21	17	33	19.21	35.21
		30	60	2.21	17	33	19.21	35.21
		60	15	2.21	17	33	19.21	35.21
		60	30	2.21	17	33	19.21	35.21
		60	60	2.21	17	33	19.21	35.21

2	120	60	60	2.21	8	33	10.21	35.21
		60	120	2.21	8	33	10.21	35.21
		120	60	2.21	4	33	6.21	35.21
		120	120	2.21	4	33	6.21	35.21
	240	60	60	2.21	8	33	10.21	35.21
		60	120	2.21	8	33	10.21	35.21
		120	60	2.21	4	33	6.21	35.21
		120	120	2.21	4	33	6.21	35.21

- [195] From the above table, the present specification proposes MTTD for inter-band synchronous EN-DC. Proposal 4a: For inter-band synchronous EN-DC with considering UE complexity of implementation, MTTD is proposed with 19.21us, 10.21us and 6.21us for DL NR SCS of 30kHz, 60kHz and 120kHz respectively in addition to 35.21us corresponding to DL NR SCS of 15kHz.
- [196] Proposal5a: For inter-band synchronous EN-DC without considering UE complexity of implementation, MTTD is proposed with 35.21us for all NR SCS. That is, MTTD is proposed with 35.21 us regardless of whether SCS is 15 kHz, 30 kHz, 60 kHz or 120 kHz. Here, as above explained, EN-DC means that a first cell and a second cell are configured for dual connectivity. And, the first cell is an E-UTRA based cell and the second cell is a NR based cell. The first cell is a primary cell and the second cell is a secondary cell.
- [197] Above proposals, DL NR SCS is minimum SCS between NR SSB SCS and NR DL DATA SCS. The below table shows our proposed MRTD and MTTD for inter-band synchronous EN-DC.
- [198] The below table shows the proposed MRTD and MTTD for inter-band synchronous EN-DC

[199] [Table 27]

	considering UE complexity				Not considering UE complexity			
DL NR SCS(kHz)	15	30	60	120	15	30	60	120
MRTD (us)	33	17	8	4	33	33	33	33
MTTD (us) : option1	35.21	19.21	9.7	5.7	35.21	35.21	34.7	34.7
MTTD (us) : option2	35.21	19.21	10.21	6.21	35.21	35.21	35.21	35.21

[200] Here, DL NR Sub-carrier spacing is $\min\{SCS_{SS}, SCS_{DATA}\}$. Proposal5: For inter-band synchronous EN-DC without considering UE complexity of implementation, MTTD is proposed with 35.21us for DL NR SCS of 15kHz and 30kHz, and 34.7us for DL NR SCS of 60kHz and 120kHz.

[201] **I-1. Modification to 3GPP standard based on the first disclosure**

[202] I-1-1. Maximum Transmission Timing Difference

[203] A UE shall be capable of handling a relative transmission timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated E-UTRA-NR dual connectivity.

[204] Minimum Requirements for E-UTRA-NR Dual Connectivity is as follows:

[205] For inter-band E-UTRA-NR dual connectivity, the UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in the below table. The below table shows a maximum uplink transmission timing difference requirement for asynchronous operation.

[206] [Table 28]

Sub-carrier spacing in E-UTRA PCell (kHz)	UL Sub-carrier spacing for data in PSCell (kHz)	Maximum uplink transmission timing difference (μs)
15	15	500
15	30	250
15	60	125
15	120Note1	62.5
Note1 : For intra-band FDD-FDD E-UTRA-NR dual connectivity, 120kHz is not applied.		

[207] For inter-band TDD-TDD (E-UTRA PCell-PSCell) and inter-band TDD-FDD (E-UTRA PCell-PSCell or PSCell-E-UTRA PCell) combinations, the UE shall meet the requirements in the above table provided that the UE indicates that it is capable of asynchronous dual connectivity. For inter-band TDD-TDD (E-UTRA PCell-PSCell) and inter-band TDD-FDD (E-UTRA PCell-PSCell or PSCell-E-UTRA PCell) combinations, the UE shall meet the requirements in the below table provided that the UE indicates that it is capable of synchronous dual connectivity only. The UE is assumed that there is no limitation of implementation related to power control and ACG within 33us.

[208] The below table shows a maximum uplink transmission timing difference requirement for synchronous operation in inter-band TDD-TDD and TDD-FDD combinations.

[209] [Table 29]

Sub-carrier spacing in E-UTRA PCell (kHz)	UL Sub-carrier spacing for data in PSCell (kHz)	Maximum uplink transmission timing difference (μ s)
15	15	35.21
15	30	35.21
15	60	34.7
15	120	34.7

[210] For inter-band TDD-TDD (E-UTRA PCell-PSCell) and inter-band TDD-FDD (E-UTRA PCell-PSCell or PSCell-E-UTRA PCell) combinations, the UE shall meet the requirements in the below table provided that the UE indicates that it is capable of synchronous dual connectivity only within NR one half symbol duration. The below table shows a maximum uplink transmission timing difference requirement for synchronous operation in inter-band TDD-TDD and TDD-FDD combinations within NR one half symbol duration

[211] [Table 30]

Sub-carrier spacing in E-UTRA PCell (kHz)	UL Sub-carrier spacing for data in PSCell (kHz)	Maximum uplink transmission timing difference (μ s)
15	15	35.21
15	30	19.21
15	60	9.7
15	120	5.7

- [212] For intra-band FDD-FDD E-UTRA-NR dual connectivity with collocated deployment, the UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in above table provided the UE indicates that it is capable of asynchronous dual connectivity. For intra-band TDD-TDD E-UTRA-NR dual connectivity with collocated deployment, only synchronous and collocated operation is allowed, thus no uplink transmission timing difference is applicable.
- [213] I-1-2. Maximum Receive Timing Difference
- [214] A UE shall be capable of handling a relative receive timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated for E-UTRA-NR dual connectivity.
- [215] A UE shall be capable of handling a relative receive timing difference between slot timing boundary of different carriers to be aggregated NR carrier aggregation.
- [216] Minimum Requirements for E-UTRA-NR Dual Connectivity is as follows:
- [217] For inter-band E-UTRA-NR dual connectivity, the UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell at the UE receiver as shown in below table.
- [218] The below table shows maximum receive timing difference requirement for asynchronous operation.
- [219] [Table 31]

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz)Note1	Maximum receive timing difference (μ s)
15	15	500
15	30	250
15	60	125
15	120	62.5
Note1 : DL Sub-carrier spacing is $\min\{SCS_{SS}, SCS_{DATA}\}$. Note2 : For intra-band FDD-FDD E-UTRA-NR dual connectivity, 120kHz is not applied.		

- [220] For inter-band TDD-TDD (E-UTRA PCell-PSCell) and inter-band TDD-FDD (E-UTRA PCell-PSCell or PSCell-E-UTRA PCell) combinations, the UE shall meet the requirements in the above table provided that the UE indicates that it is capable of asynchronous dual connectivity. For inter-band TDD-TDD (E-UTRA PCell-PSCell) and inter-band TDD-FDD (E-UTRA PCell-PSCell or PSCell-E-UTRA PCell) combinations, the UE shall meet the requirements in the below table provided that the UE indicates that it is capable of synchronous dual connectivity only. The UE is assumed

that there is no limitation of implementation related to power control and ACG within 33 μ s.

[221] The below table shows a maximum receive timing difference requirement for synchronous operation in inter-band TDD-TDD and TDD-FDD combinations.

[222] [Table 32]

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz)Note1	Maximum receive timing difference (μ s)
15	15	33
15	30	33
15	60	33
15	120	33
Note1: DL Sub-carrier spacing is $\min\{SCS_{SS}, SCS_{DATA}\}$.		

[223] For inter-band TDD-TDD (E-UTRA PCell-PSCell) and inter-band TDD-FDD (E-UTRA PCell-PSCell or PSCell- E-UTRA PCell) combinations, the UE shall meet the requirements in the below table provided that the UE indicates that it is capable of synchronous dual connectivity only within NR one half symbol duration. The below table shows a maximum receive timing difference requirement for synchronous operation in inter-band TDD-TDD and TDD-FDD combinations within NR one half symbol duration.

[224] [Table 33]

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz)Note1	Maximum receive timing difference (μ s)
15	15	33
15	30	17
15	60	8
15	120	4
Note1: DL Sub-carrier spacing is $\min\{SCS_{SS}, SCS_{DATA}\}$.		

[225] For intra-band FDD-FDD E-UTRA-NR dual connectivity with collocated deployment, the UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell as shown in the table provided the UE indicates that it is capable of asynchronous dual connectivity. For intra-band E-UTRA-NR dual connectivity with collocated deployment, the UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot

timing of signal from PSCell as shown in the below table provided the UE indicates that it is only capable of synchronous dual connectivity.

[226] The below table shows a maximum receive timing difference requirement for synchronous operation in intra-band collocation scenario.

[227] [Table 34]

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz)Note1	Maximum receive timing difference (μ s)
15	15	[3]
15	30	[3]
15	60	[3]
Note1: DL Sub-carrier spacing is $\min\{SCS_{SS}, SCS_{DATA}\}$.		

[228] **II. Second Disclosure**

[229] The second disclosure provides a behavior and/or requirement of a wireless device related to a maximum receive timing difference (MRTD) and a maximum transmission timing difference (MTTD) in a NR carrier aggregation.

[230] In general, Carrier Aggregation (CA) is operated in synchronized networks. At UE side, maximum received timing difference (MRTD) between from NR PCell NodeB to UE and from NR SCell NodeB to UE is defined as follows. The MRTD can be applied to NR SCells.

[231] $MRTD = TAE + \text{Propagation delay difference}$

[232] TAE (Timing Alignment Error) was specified as follows in TS38.104.

[233] 3 μ s for inter-band NR CA

[234] 3 μ s for intra-band non-contiguous NR CA

[235] 260ns for intra-band contiguous NR CA

[236] Here, the explanation about the TAE is as follows:

[237] This requirement shall apply to frame timing in TX diversity, MIMO transmission, carrier aggregation and their combinations.

[238] Frames of the NR signals present at the BS transmitter antenna connectors or TAB connectors are not perfectly aligned in time. The RF signals present at the BS transmitter antenna connectors or transceiver array boundary may experience certain timing differences in relation to each other.

[239] The TAE is specified for a specific set of signals/transmitter configuration/transmission mode.

[240] For BS type 1-C, the TAE is defined as the largest timing difference between any two signals belonging to different antenna connectors for a specific set of signals/transmitter configuration/transmission mode.

- [241] For BS type 1-H, the TAE is defined as the largest timing difference between any two signals belonging to TAB connectors belonging to different transmitter groups at the transceiver array boundary, where transmitter groups are associated with the TAB connectors in the transceiver unit array corresponding to TX diversity, MIMO transmission, carrier aggregation for a specific set of signals/transmitter configuration/transmission mode.
- [242] Minimum requirement for BS type 1-C and 1-H
- [243] For MIMO or TX diversity transmissions, at each carrier frequency, TAE shall not exceed 65ns.
- [244] For intra-band contiguous carrier aggregation, with or without MIMO or TX diversity, TAE shall not exceed 260ns.
- [245] For intra-band non-contiguous carrier aggregation, with or without MIMO or TX diversity, TAE shall not exceed 3 μ s.
- [246] For inter-band carrier aggregation, with or without MIMO or TX diversity, TAE shall not exceed 3 μ s.
- [247] Propagation delay difference can be calculated with following assumption of distance difference between from NR PCell NodeB to UE and from NR SCell NodeB to UE for deployment scenarios.
- [248] Frequency Range 1(FR1) : below 6GHz
- [249] Frequency Range 2(FR2) : mmWave
- [250] Distance difference : 9km
- [251] - FR1(PCell) & FR1(SCell), FR1(SCell) & FR1(SCell)
- [252] - FR1(PCell) & FR2(SCell), FR1(SCell) & FR2(SCell),
- [253] Distance difference : 1.5km
- [254] - FR2(PCell) & FR2(SCell), FR2(SCell) & FR2(SCell)
- [255] For simple explanation, combination of PCell and SCell is assumed below. However it can be applied for multiple SCells.
- [256] Propagation delay difference
- [257] $30\mu\text{s} = 9\text{km}/(3 \times 10^8\text{m/s})$ for 9km(Distance difference)
- [258] $5\mu\text{s} = 1.5\text{km}/(3 \times 10^8\text{m/s})$ for 1.5km(Distance difference)
- [259] Regarding TAE and Propagation delay difference, MRTD can be 33 μs for distance difference of 9km and 8 μs for distance difference of 1.5km.
- [260] In general, Maximum Transmission Timing Difference(MTTD) is defined as follows.
- [261] $\text{MTTD} = \text{MRTD} + \text{Transmission timing Error} + \text{Uncertainty of receiving time}$
- [262] $\text{Transmission timing Error} = \text{Transmission timing Error for PCell} + \text{Transmission timing Error for SCell}$
- [263] $\text{Uncertainty of receiving time} = \text{Uncertainty of receiving time for PCell} + \text{Uncertainty of receiving time for SCell}$

[264] Transmission timing error was specified differently depending on SubCarrier Spacing(SCS) for NR.

[265] In NR, SCS was defined for Data and Synchronization Signal(SS) as follows.

[266] [Table 35]

SCS	DATA		SS	
	FR1	FR2	FR1	FR2
15kHz	√		√	
30kHz	√		√	
60kHz	√	√ _v		
120kHz		√		√
240kHz				√

[267] The below table shows T_e Timing Error Limit.

[268] [Table 36]

Frequency Range	SCS of SSB signals (KHz)	SCS of uplink signals s(KHz)	T_e
FR1	15	15	$[12]*64*T_e$
		30	$[10]*64*T_e$
		60	$[10]*64*T_e$
	30	15	$[8]*64*T_e$
		30	$[8]*64*T_e$
		60	$[7]*64*T_e$
FR2	120	60	$[3.5]*64*T_e$
		120	$[3.5]*64*T_e$
	240	60	$[3]*64*T_e$
		120	$[3]*64*T_e$

[269] Here, T_e is the basic timing unit. Also, $T_e = T_s/64$, $T_s = 1/(15000*2048)$ sec. Uncertainty of receiving time can be different depending on applied SCS.

[270] [Table 37]

DATA SCS	T_u : uncertainty of receiving time (T_s) for PCell or SCell
15	10
30	5
60	2.5
120	1.25

[271] For Transmission timing Error + Uncertainty of receiving time, maximum value : $44T_s(1.43\mu s) = [12]*64*T_c + [12]*64*T_c + 10T_s + 10T_s$ for FR1(PCell) + FR1(SCell)

[272] minimum value : $8.5T_s(0.28\mu s) = [3]*64*T_c + [3]*64*T_c + 1.25T_s + 1.25T_s$ for FR2(PCell) + FR1(SCell)

[273] One value can be use with representative value to avoid complicated requirement since the value is very small comparing MRTD in variance aspect. Regarding co-operation with E-UTRA(LTE), it is proposed to use 2.21 us for the transmission timing Error + uncertainty of receiving time.

[274] Based on the TAE and propagation delay difference, corresponding MRTD can be defined.

[275] For inter-band NR CA

[276] - When UE is configured as NR CA in FR1 : MRTD = $33\mu s$

[277] - When UE is configured as NR CA in FR2 : MRTD = $8\mu s$

[278] - When UE is configured as NR CA in mixed FR1 & FR2 : MRTD = $33\mu s$

[279] For intra-band non-contiguous NR CA

[280] - When UE is configured as NR CA in FR1 : MRTD = $33\mu s$

[281] - When UE is configured as NR CA in FR2 : MRTD = $8\mu s$

[282] The MRTD requirements should be applied for when one SCell is configured and when multiple SCells are configured.

[283] For NR CA MTTD, the requirement is not necessary for intra-band contiguous NR CA since it is meaningless regarding simultaneous transmission, however it is necessary for intra-band non-contiguous NR CA and inter-band NR CA like LTE CA. The MTTD can be addressed by adding $2.21\mu s$ to MRTD like EN-DC.

[284] For inter-band NR CA

[285] - When UE is configured as NR CA in FR1 : MTTD = $35.21\mu s$

[286] - When UE is configured as NR CA in FR2 : MTTD = $10.21\mu s$

[287] - When UE is configured as NR CA in mixed FR1 & FR2 : MTTD = $35.21\mu s$

[288] For intra-band non-contiguous NR CA

[289] When UE is configured as NR CA in FR1 : MTTD = $35.21\mu s$

- [290] When UE is configured as NR CA in FR2 : MTTD = 10.21 μ s
- [291] In addition to MTTD, like LTE CA, related UE behaviour needs to be specified if after timing adjusting due to received TA command the uplink transmission timing difference between PCell and SCell exceeds the maximum value the UE can handle. The UE behaviour can reuse LTE CA with only replacement of MTTD.
- [292] In LTE CA, related requirement for Maximum Transmission Timing Difference in Carrier Aggregation is specified as follows:
- [293] A UE shall be capable of handling a relative received time difference between the PCell and SCell to be aggregated in inter-band CA and intra-band non-contiguous CA.
- [294] Minimum Requirements for Interband Carrier Aggregation is as follows:
- [295] The UE shall be capable of handling at least a relative received timing difference between the subframe timing boundaries of the signals received from the PCell and the SCell at the UE receiver of up to 30.26 μ s when one SCell is configured.
- [296] When two, three, or four SCells are configured, the UE shall be capable of handling at least a relative propagation delay difference between the subframe timing boundaries of the signals received from any pair of the serving cells (PCell and the SCells) at the UE receiver of up to 30.26 μ s.
- [297] The UE shall be capable of handling a maximum uplink transmission timing difference between the pTAG and the sTAG of at least 32.47 μ s provided that the UE is:
- [298] - configured with inter-band CA and
- [299] - configured with the pTAG and the sTAG,
- [300] A UE configured with pTAG and sTAG may stop transmitting on the SCell if after timing adjusting due to received TA command the uplink transmission timing difference between PCell and SCell exceeds the maximum value the UE can handle as specified above.
- [301] The UE shall be capable of handling a maximum uplink transmission timing difference between the pTAG and any of the two sTAGs or between the two sTAGs of at least 32.47 μ s provided that the UE is:
- [302] - configured with inter-band CA and
- [303] - configured with the two sTAGs,
- [304] A UE configured with two sTAGs may stop transmitting on the SCell if after timing adjusting due to received TA command the uplink transmission timing difference between SCell in one sTAG and SCell in other sTAG exceeds the maximum value the UE can handle as specified above.
- [305] Minimum Requirements for Intra-band non-contiguous Carrier Aggregation is as follows:
- [306] The UE shall be capable of handling at least a relative received timing difference

between the subframe timing boundaries of the signals received from the PCell and the SCell at the UE receiver of up to 30.26 μ s.

- [307] The UE shall be capable of handling a maximum uplink transmission timing difference between the pTAG and the sTAG of at least 32.47 μ s provided that the UE is:
- [308] - configured with intra-band non-contiguous CA and
- [309] - configured with the pTAG and the sTAG,
- [310] A UE configured with pTAG and sTAG may stop transmitting on the SCell if after timing adjusting due to received TA command the uplink transmission timing difference between PCell and SCell exceeds the maximum value the UE can handle as specified above.
- [311] Proposal 1: For inter-band NR CA, define MRTD with 33 μ s for FR1, 8 μ s for FR2 and 33 μ s for mixed FR1 and FR2.
- [312] Proposal 2: For intra-band non-contiguous NR CA, define MRTD with 33 μ s for FR1 and 8 μ s for FR2.
- [313] Proposal 3: For intra-band contiguous NR CA, don not define MRTD for FR1 and FR2.
- [314] Proposal 4: For inter-band NR CA, define MTTD with 35.21 μ s for FR1, 10.21 μ s for FR2 and 35.21 μ s for mixed FR1 and FR2.
- [315] Proposal 5: For intra-band non-contiguous NR CA, define MTTD with 35.21 μ s for FR1 and 10.21 μ s for FR2.
- [316] Proposal 6: For intra-band contiguous NR CA, don not define MTTD for FR1 and FR2.
- [317] Proposal 7: Define UE behaviour related to NR CA MTTD for inter-band NR CA and intra-band non-contiguous NR CA.
- [318] Based on the proposed MRTD, MTTD and UE behaviour, we propose related requirement for NR CA with underline as follows.

[319] **II-1. Modification to 3GPP standard based on the first disclosure**

[320] **II-1-1. Maximum Transmission Timing Difference**

- [321] A UE shall be capable of handling a relative transmission timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated EN-DC.
- [322] A UE shall be capable of handling a relative transmission timing difference between slot timing boundary of different carriers to be aggregated in inter-band NR CA and intra-band non-contiguous NR CA.
- [323] Minimum Requirements for inter-band EN-DC is as follows:
- [324] The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in the below table. The re-

quirements for asynchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA FDD- NR FDD, E-UTRA FDD-NR TDD and E-UTRA TDD-NR FDD inter-band asynchronous EN-DC.

[325] Below table shows a maximum uplink transmission timing difference requirement for asynchronous EN-DC

[326] [Table 38]

Sub-carrier spacing in E-UTRA PCell (kHz)	UL Sub-carrier spacing for data in PSCell (kHz)	Maximum uplink transmission timing difference (μ s)
15	15	500
15	30	250
15	60	125
15	120Note1	62.5
Note1 : For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

[327] The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in the below table provided that the UE indicates that it is capable of synchronous EN-DC. The requirements for synchronous EN-DC are applicable for E-UTRA TDD-NR TDD, E-UTRA TDD-NR FDD and E-UTRA FDD-NR TDD inter-band EN-DC. Below table shows a maximum uplink transmission timing difference requirement for inter-band synchronous EN-DC.

[328] [Table 39]

Sub-carrier spacing in E-UTRA PCell (kHz)	UL Sub-carrier spacing for data in PSCell (kHz)	Maximum uplink transmission timing difference (μ s)
15	15	35.21
15	30	35.21
15	60	35.21
15	120 Note1	35.21
Note 1: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

[329] Minimum Requirements for intra-band EN-DC is as follows: For intra-band EN-DC, only collocated deployment is applied.

[330] The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in Table 7.5.2-1 provided the UE indicates that it is capable of asynchronous EN-DC. The requirements for asyn-

chronous EN-DC are applicable for E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band asynchronous EN-DC.

[331] No uplink transmission timing difference is applicable for synchronous EN-DC.

[332] Minimum Requirements for inter-band NR CA is proposed as follows:

[333] The UE shall be capable of handling a maximum uplink transmission timing difference between the pTAG and the sTAG of at least 35.21 μ s for FR1, 10.21 μ s for FR2 and 35.21 μ s for mixed FR1 and FR2 provided that the UE is:

[334] - configured with inter-band CA and

[335] - configured with the pTAG and the sTAG,

[336] A UE configured with pTAG and sTAG may stop transmitting on the SCell if after timing adjusting due to received TA command the uplink transmission timing difference between PCell and SCell exceeds the maximum value the UE can handle as specified above.

[337] The UE shall be capable of handling a maximum uplink transmission timing difference between the pTAG and any of the two sTAGs or between the two sTAGs of at least 35.21 μ s for FR1, 10.21 μ s for FR2 and 35.21 μ s for mixed FR1 and FR2 provided that the UE is:

[338] - configured with inter-band CA and

[339] - configured with the two sTAGs,

[340] A UE configured with two sTAGs may stop transmitting on the SCell if after timing adjusting due to received TA command the uplink transmission timing difference between SCell in one sTAG and SCell in other sTAG exceeds the maximum value the UE can handle as specified above.

[341] Minimum Requirements for intra-band non-contiguous NR CA is proposed as follows:

[342] The UE shall be capable of handling a maximum uplink transmission timing difference between the pTAG and the sTAG of at least 35.21 μ s for FR1 and 10.21 μ s for FR2 provided that the UE is:

[343] - configured with inter-band CA and

[344] - configured with the pTAG and the sTAG,

[345] A UE configured with pTAG and sTAG may stop transmitting on the SCell if after timing adjusting due to received TA command the uplink transmission timing difference between PCell and SCell exceeds the maximum value the UE can handle as specified above.

[346] The UE shall be capable of handling a maximum uplink transmission timing difference between the pTAG and any of the two sTAGs or between the two sTAGs of at least 35.21 μ s for FR1 and 10.21 μ s for FR2 provided that the UE is:

[347] - configured with inter-band CA and

- [348] - configured with the two sTAGs,
- [349] A UE configured with two sTAGs may stop transmitting on the SCell if after timing adjusting due to received TA command the uplink transmission timing difference between SCell in one sTAG and SCell in other sTAG exceeds the maximum value the UE can handle as specified above.
- [350] In addition, for stopping transmission under above condition, Network needs to know it once measured MTTD is larger than the requirement (e.g. 35.21us for FR1 and 10.21us for FR2) . So, it is proposed that that a signaling is needed to indicate from UE to Network(NodeB) for Network's proper scheduling of CA when UE stops transmission on the SCell as shown in Fig. 10b.
- [351] And/Or we propose that if MRTD is larger than the requirement in NR CA (e.g. 33μs for FR1, 8μs for FR2 and 33μs for mixed FR1 and FR2 in 7.6 below), a UE configured with two sTAGs may stop transmitting on the SCell. So, a signaling is needed to indicate from UE to Network (NodeB) when UE stops transmission on the SCell.
- [352] **Fig. 10a shows an example case of $MTTD \leq T_{thr}$, Fig. 10b shows an example case of $MTTD > T_{thr}$ and Fig. 10c shows an example case of $MTTD > T_{thr}$ and $MTTD \leq T_{thr}$.**
- [353] Here, T_{thr} is the minimum requirement of MTTD (e.g. 35.21us for FR1 and 10.21us for FR2). From Fig. 10c, it is proposed that signaling is also needed to indicate to Network(NodeB) re-transmission on SCell when MTTD is equal to or smaller than the requirement.
- [354] **II-1-2. Maximum Receive Timing Difference**
- [355] A UE shall be capable of handling a relative receive timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated for EN-DC.
- [356] A UE shall be capable of handling a relative receive timing difference between slot timing boundary of different carriers to be aggregated in inter-band NR CA and intra-band non-contiguous NR CA.
- [357] Minimum Requirements for inter-band EN-DC is as follows:
- [358] The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell at the UE receiver as shown in the below table. The requirements for asynchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA FDD- NR FDD, E-UTRA FDD- NR TDD and E-UTRA TDD- NR FDD inter-band EN-DC.
- [359] Below table shows Maximum receive timing difference requirement for asynchronous EN-DC.

[360] [Table 40]

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz)Note1	Maximum receive timing difference (μ s)
15	15	500
15	30	250
15	60	125
15	120	62.5
Note1 : DL Sub-carrier spacing is $\min\{\text{SCSSS}, \text{SCSDATA}\}$. Note2 : For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

[361] The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell at the UE receiver as shown in the below table provided that the UE indicates that it is capable of synchronous EN-DC. The requirements for synchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA TDD- NR FDD and E-UTRA FDD- NR TDD inter-band EN-DC.

[362] Below table shows Maximum receive timing difference requirement for inter-band synchronous EN-DC.

[363] [Table 41]

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz)Note1	Maximum receive timing difference (μs)
15	15	33
15	30	
15	60	
15	120	
Note1: DL Sub-carrier spacing is min{SCS _{SS} , SCS _{DATA} }.Note2: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

[364] Minimum Requirements for intra-band EN-DC is as follows: For intra-band EN-DC, only collocated deployment is applied.

[365] The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell as shown in the below table provided the UE indicates that it is capable of asynchronous EN-DC. The requirements for asynchronous EN-DC are applicable for E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC.

[366] The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell as shown in the below table provided the UE indicates that it is only capable of synchronous EN-DC. The requirements for synchronous EN-DC are applicable for E-UTRA TDD- NR TDD and E-UTRA FDD- NR FDD intra-band EN-DC.

[367] Below table shows Maximum receive timing difference requirement for intra-band synchronous EN-DC.

[368] [Table 42]

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz) Note1	Maximum receive timing difference (μ s)
15	15	3
15	30	3
15	60	3
Note1: DL Sub-carrier spacing is $\min\{SCS_{SS}, SCS_{DATA}\}$.		

[369] Minimum Requirements for inter-band NR CA is proposed as follows: The UE shall be capable of handling at least a relative received timing difference between the slot timing boundaries of the signals received from the PCell and the SCell at the UE receiver of up to 33 μ s for FR1, 8 μ s for FR2 and 33 μ s for mixed FR1 and FR2 when one SCell is configured.

[370] When multiple SCells are configured, the UE shall be capable of handling at least a relative propagation delay difference between the slot timing boundaries of the signals received from any pair of the serving cells (PCell and the SCells) at the UE receiver of up to 33 μ s for FR1, 8 μ s for FR2 and 33 μ s for mixed FR1 and FR2.

[371] Minimum Requirements for intra-band non-contiguous NR CA is proposed as follows:

[372] The UE shall be capable of handling at least a relative received timing difference between the slot timing boundaries of the signals received from the PCell and the SCell at the UE receiver of up to 33 μ s for FR1 and 8 μ s for FR2 when one SCell is configured.

[373] When multiple SCells are configured, the UE shall be capable of handling at least a relative propagation delay difference between the slot timing boundaries of the signals received from any pair of the serving cells (PCell and the SCells) at the UE receiver of up to 33 μ s for FR1 and 8 μ s for FR2.

[374] The above-described embodiments of the present invention may be implemented by use of various means. For example, the embodiments of the present invention may be

implemented by hardware, firmware, and software or a combination thereof. A detailed description thereof will be provided with reference to drawings.

[375] **FIG. 11 is a block diagram illustrating a wireless device and a base station, by which the disclosure of this specification can be implemented.**

[376] Referring to FIG. 11, a wireless device 100 and a base station 200 may implement the disclosure of this specification.

[377] The wireless device 100 includes a processor 101, a memory 102, and a transceiver 103. Likewise, the base station 200 includes a processor 201, a memory 202, and a transceiver 203. The processors 101 and 201, the memories 102 and 202, and the transceivers 103 and 203 may be implemented as separate chips, or at least two or more blocks/functions may be implemented through one chip.

[378] Each of the transceivers 103 and 203 includes a transmitter and a receiver. When a particular operation is performed, either or both of the transmitter and the receiver may operate. Each of the transceivers 103 and 203 may include one or more antennas for transmitting and/or receiving a radio signal. In addition, each of the transceivers 103 and 203 may include an amplifier configured for amplifying a Rx signal and/or a Tx signal, and a band pass filter for transmitting a signal to a particular frequency band.

[379] Each of the processors 101 and 201 may implement functions, procedures, and/or methods proposed in this specification. Each of the processors 101 and 201 may include an encoder and a decoder. For example, each of the processors 101 and 202 may perform operations described above. Each of the processors 101 and 201 may include an application-specific integrated circuit (ASIC), a different chipset, a logic circuit, a data processing device, and/or a converter which converts a base band signal and a radio signal into each other.

[380] Each of the memories 102 and 202 may include a Read-Only Memory (ROM), a Random Access Memory (RAM), a flash memory, a memory card, a storage medium, and/or any other storage device.

[381] **FIG. 12 is a detailed block diagram illustrating a transceiver of the wireless device shown in FIG. 11.**

[382] Referring to FIG. 12, a transceiver 110 includes a transmitter 111 and a receiver 112. The transmitter 111 includes a Discrete Fourier Transform (DFT) unit 1111, a subcarrier mapper 1112, an IFFT unit 1113, a CP insertion unit 1114, a wireless transmitter 1115. In addition, the transceiver 110 may further include a scramble unit (not shown), a modulation mapper (not shown), a layer mapper (not shown), and a layer permutator, and the transceiver 110 may be disposed in front of the DFT unit 1111. That is, in order to prevent a peak-to-average power ratio (PAPR) from increasing, the transmitter 111 may transmit information to pass through the DFT unit 1111 before mapping a signal to a subcarrier. A signal spread (or pre-coded for the

same meaning) by the DFT unit 111 is subcarrier-mapped by the subcarrier mapper 1112, and then generated as a time domain signal by passing through the IFFT unit 1113.

- [383] The DFT unit 111 performs DFT on input symbols to output complex-valued symbols. For example, if N_{tx} symbols are input (here, N_{tx} is a natural number), a DFT size may be N_{tx} . The DFT unit 1111 may be called a transform precoder. The subcarrier mapper 1112 maps the complex-valued symbols to subcarriers of a frequency domain. The complex-valued symbols may be mapped to resource elements corresponding to a resource block allocated for data transmission. The subcarrier mapper 1112 may be called a resource element mapper. The IFFT unit 1113 may perform IFFT on input symbols to output a baseband signal for data, which is a time-domain signal. The CP inserter 1114 copies a rear portion of the baseband signal for data and inserts the copied portion into a front part of the baseband signal. The CP insertion prevents Inter-Symbol Interference (ISI) and Inter-Carrier Interference (ICI), and therefore, orthogonality may be maintained even in multi-path channels.
- [384] Meanwhile, the receiver 112 includes a wireless receiver 1121, a CP remover 1122, an FFT unit 1123, and an equalizer 1124, and so on. The wireless receiver 1121, the CP remover 1122, and the FFT unit 1123 of the receiver 112 performs functions inverse to functions of the wireless transmitter 1115, the CP inserter 1114, and the IFFT unit 1113 of the transmitter 111. The receiver 112 may further include a demodulator.

Claims

- [Claim 1] A method for transceiving a signal, the method performed by a wireless terminal and comprising:
transmitting uplink signals to a first cell and a second cell,
wherein the first cell and the second cell are configured for a dual connectivity,
wherein the first cell is an evolved universal terrestrial radio access (E-UTRA) based cell,
wherein the second cell is a new radio access technology (NR) based cell; and
determining that a maximum transmission timing difference (MTTD) between the first cell and the second cell is $35.21\ \mu\text{s}$ for all of uplink subcarrier spacings (SCSs) of the second cell,
wherein the all of the uplink SCSs of the second cell include 15 kHz, 30 kHz, 60 kHz and 120 kHz.
- [Claim 2] The method of claim 1, further comprising:
handling the MTTD of $35.21\ \mu\text{s}$.
- [Claim 3] The method of claim 1, further comprising:
receiving downlink signals from the first cell and the second cell
determining that a maximum receive timing difference (MRTD) between the first cell and the second cell is $33\ \mu\text{s}$ for all of downlink SCSs of the second cell,
wherein the all of the downlink SCSs of the second cell include 15 kHz, 30 kHz, 60 kHz and 120 kHz.
- [Claim 4] The method of claim 1, further comprising:
handling the MRTD of $33\ \mu\text{s}$.
- [Claim 5] The method of claim 1, wherein the EN-DC is an inter-band EN-DC.
- [Claim 6] The method of claim 1, wherein the EN-DC is a synchronous EN-DC.
- [Claim 7] A wireless terminal for transceiving a signal, the wireless terminal comprising:
a transceiver which transmits uplink signals to a first cell and a second cell,
wherein the first cell and the second cell are configured for a dual connectivity,
wherein the first cell is an evolved universal terrestrial radio access (E-UTRA) based cell,
wherein the second cell is a new radio access technology (NR) based

- cell; and
a processor operatively connected to the transceiver and configured to determine that a maximum transmission timing difference (MTTD) between the first cell and the second cell is 35.21 μ s for all of uplink subcarrier spacings (SCSs) of the second cell,
wherein the all of the uplink SCSs of the second cell include 15 kHz, 30 kHz, 60 kHz and 120 kHz.
- [Claim 8] The wireless terminal of claim 7, wherein the processor is configured to:
handle the MTTD of 35.21 μ s.
- [Claim 9] The wireless terminal of claim 7, wherein the processor is configured to:
control the transceiver to receive downlink signals from the first cell and the second cell,
determine that a maximum receive timing difference (MRTD) between the first cell and the second cell is 33 μ s for all of downlink SCSs of the second cell,
wherein the all of the downlink SCSs of the second cell include 15 kHz, 30 kHz, 60 kHz and 120 kHz.
- [Claim 10] The wireless terminal of claim 7, wherein the processor is configured to:
handle the MRTD of 33 μ s.
- [Claim 11] The wireless terminal of claim 7, wherein the EN-DC is an inter-band EN-DC.
- [Claim 12] The wireless terminal of claim 7, wherein the EN-DC is a synchronous EN-DC.
- [Claim 13] A controller for wireless terminal comprising:
a processor configured to transmit, via a transceiver, uplink signals to a first cell and a second cell,
wherein the first cell and the second cell are configured for a dual connectivity,
wherein the first cell is an evolved universal terrestrial radio access (E-UTRA) based cell,
wherein the second cell is a new radio access technology (NR) based cell; and
wherein the processor is configured to determine that a maximum transmission timing difference (MTTD) between the first cell and the second cell is 35.21 μ s for all of uplink subcarrier spacings (SCSs) of

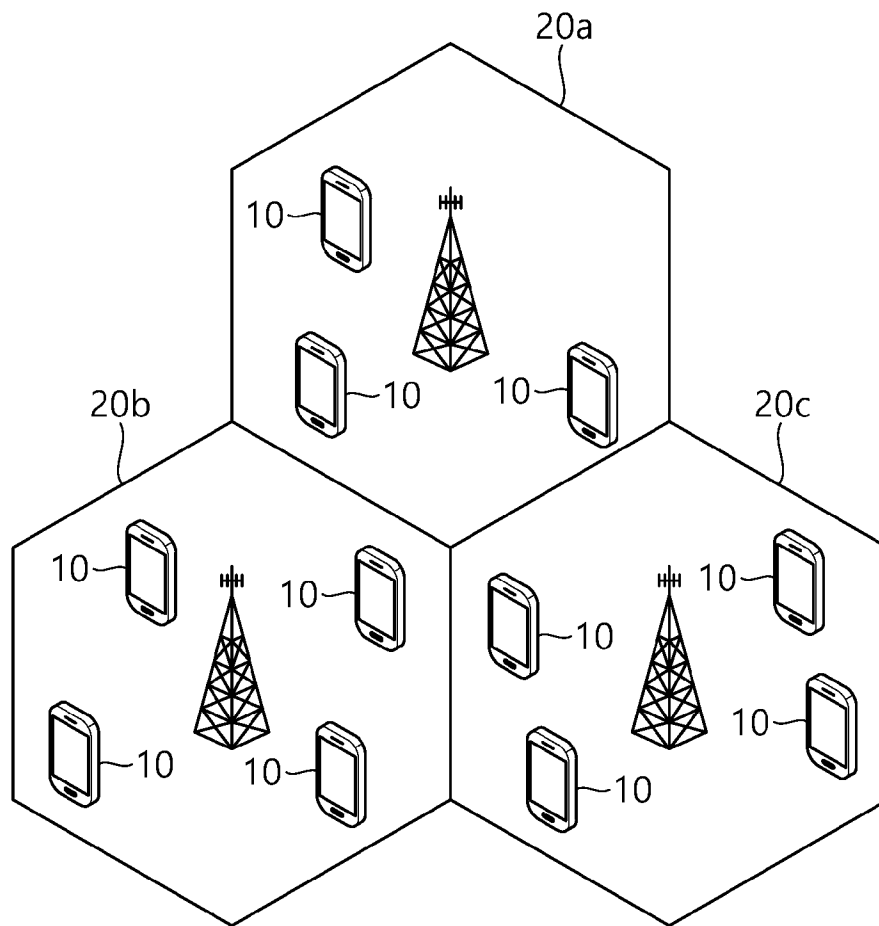
the second cell,

wherein the all of the uplink SCSs of the second cell include 15 kHz, 30 kHz, 60 kHz and 120 kHz.

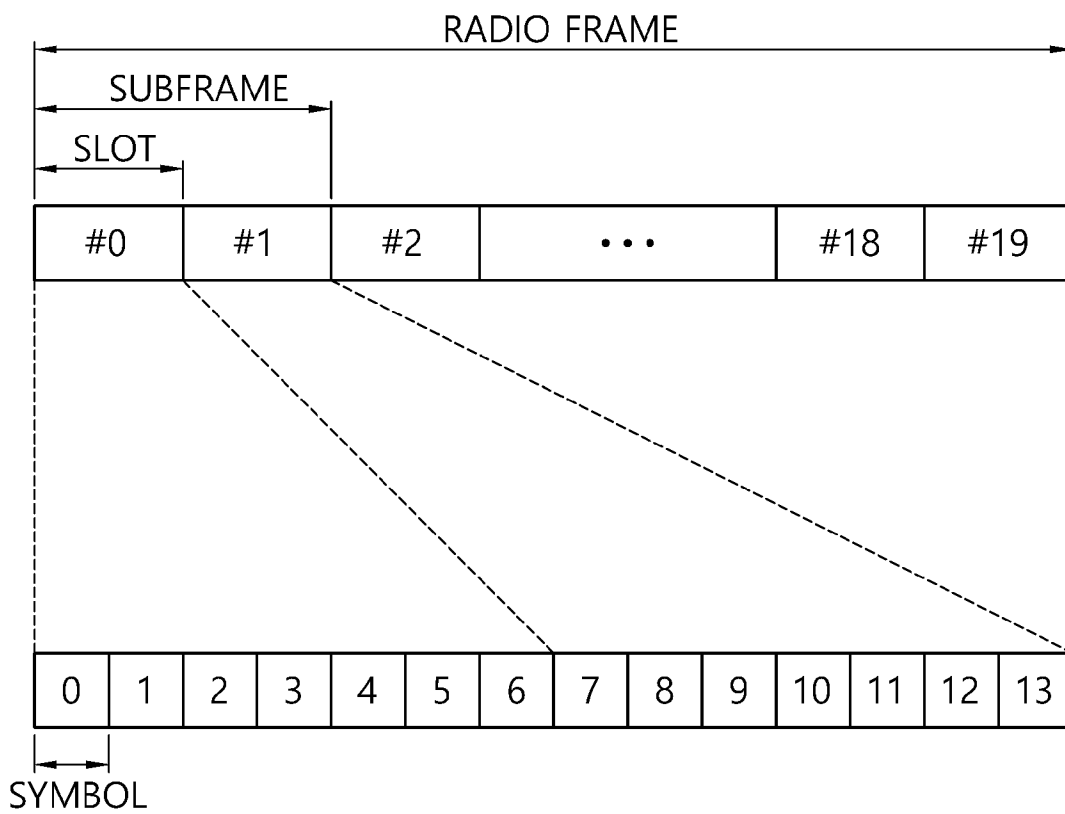
[Claim 14] The controller of claim 13, wherein the processor is configured to:
handle the MTTD of 35.21 μ s.

[Claim 15] The controller of claim 13, wherein the processor is configured to:
receive downlink signals from the first cell and the second cell,
determine that a maximum receive timing difference (MRTD) between
the first cell and the second cell is 33 μ s for all of downlink SCSs of the
second cell,
wherein the all of the downlink SCSs of the second cell include 15
kHz, 30 kHz, 60 kHz and 120 kHz.

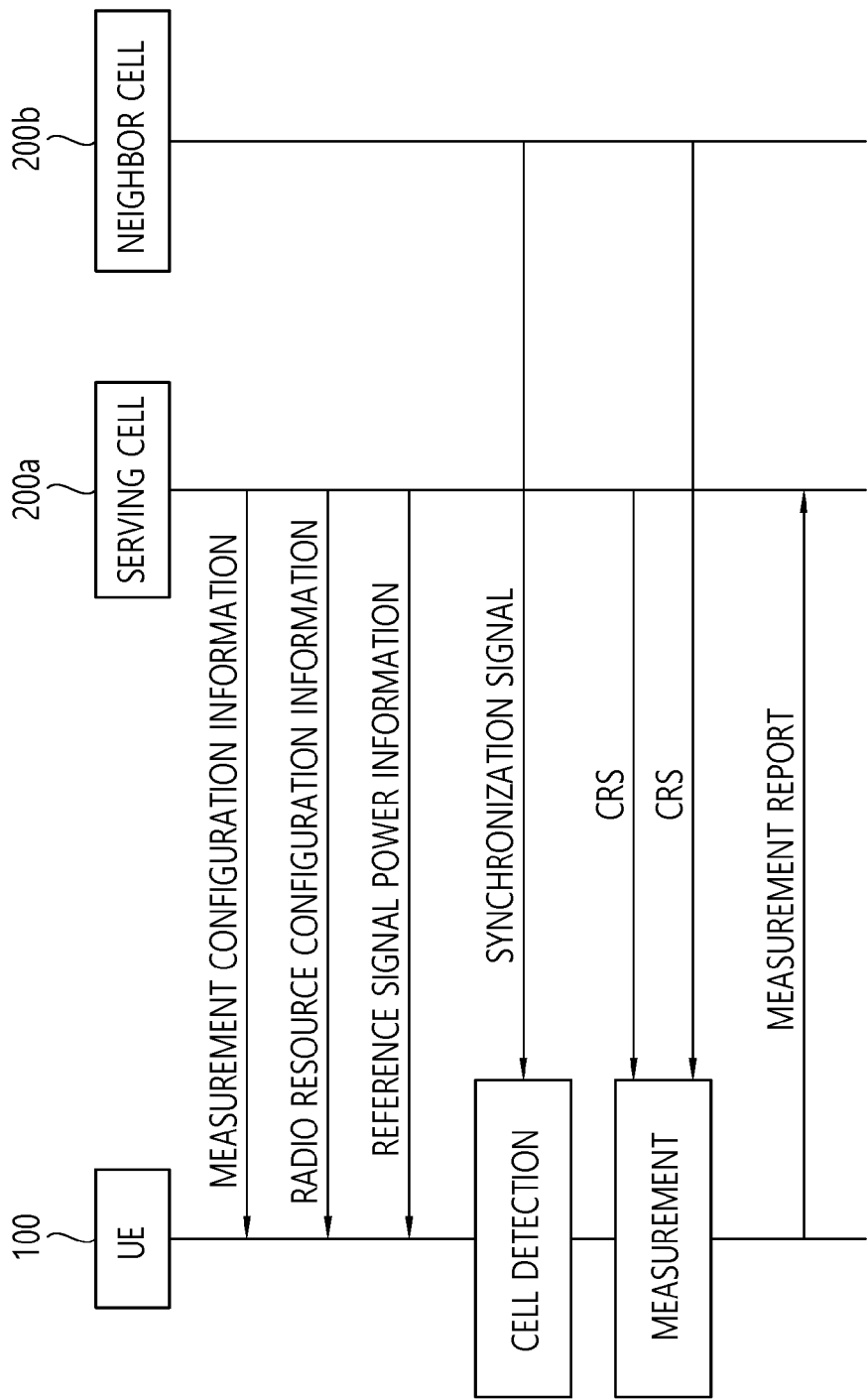
[Fig. 1]



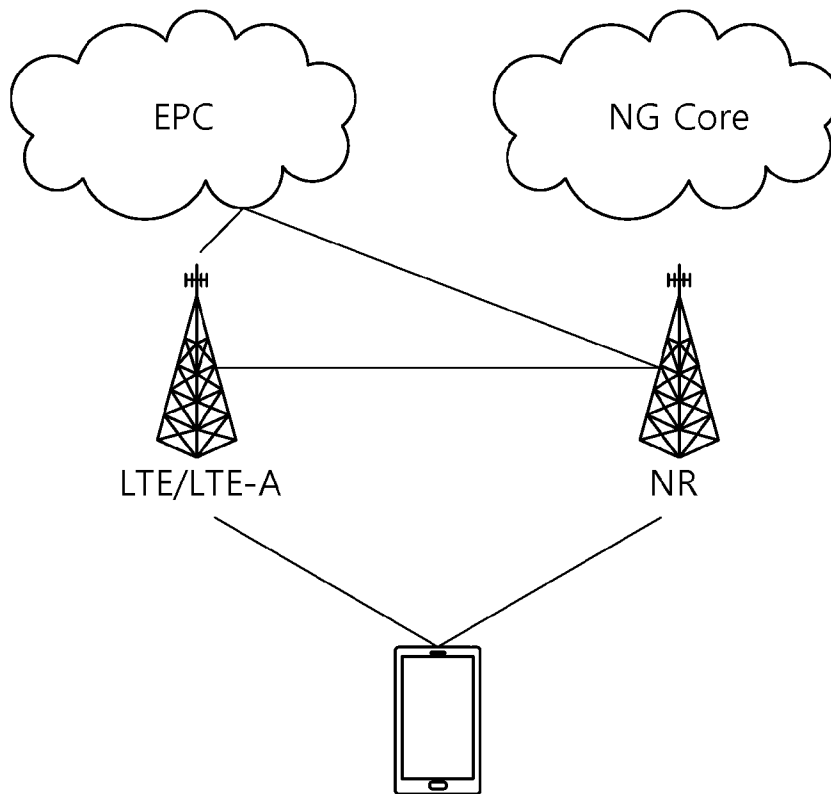
[Fig. 2]



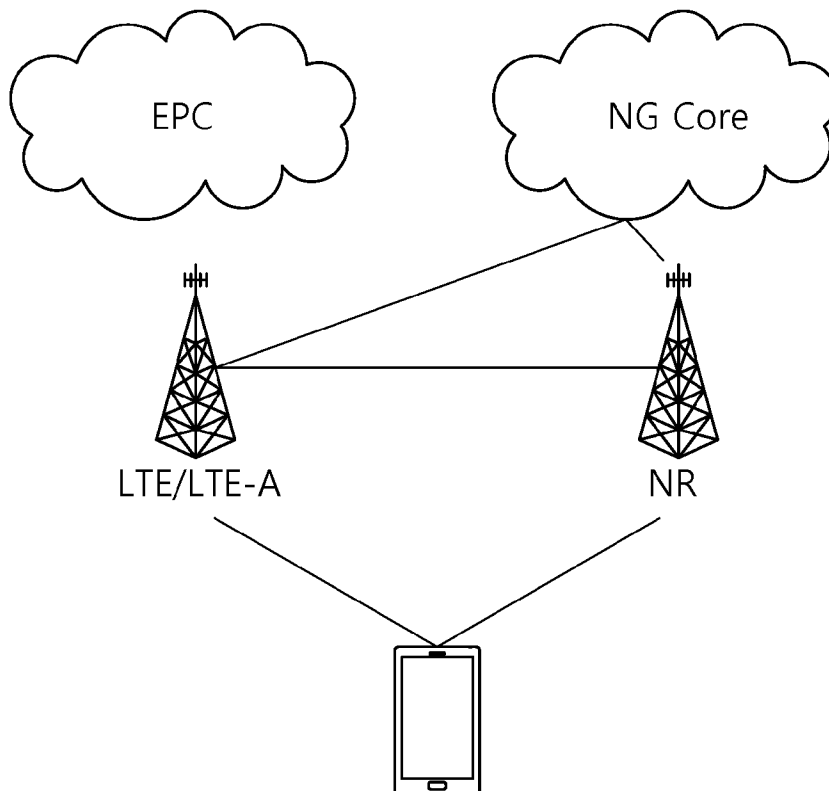
[Fig. 3]



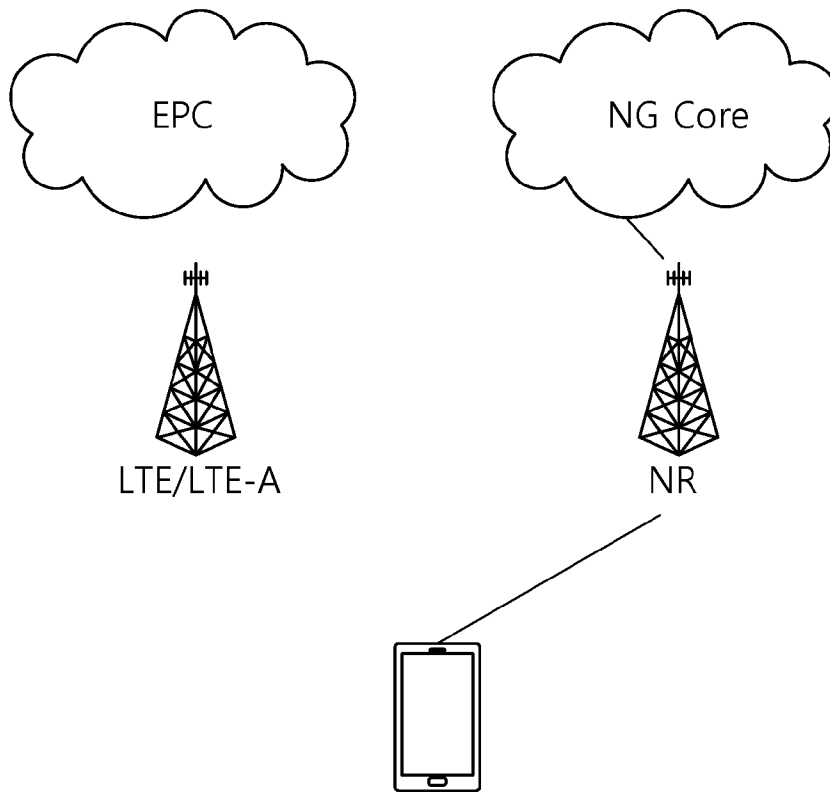
[Fig. 4a]



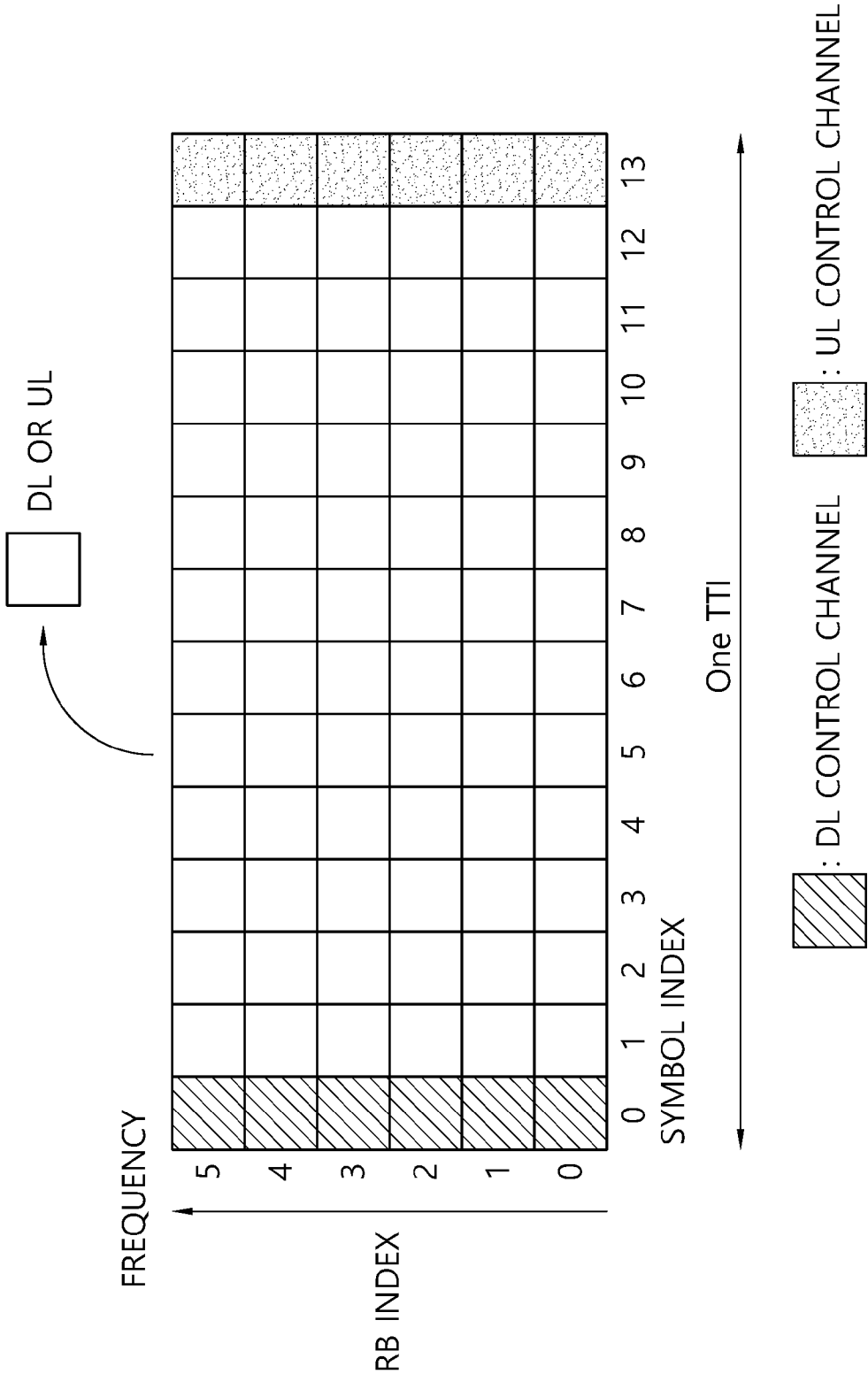
[Fig. 4b]



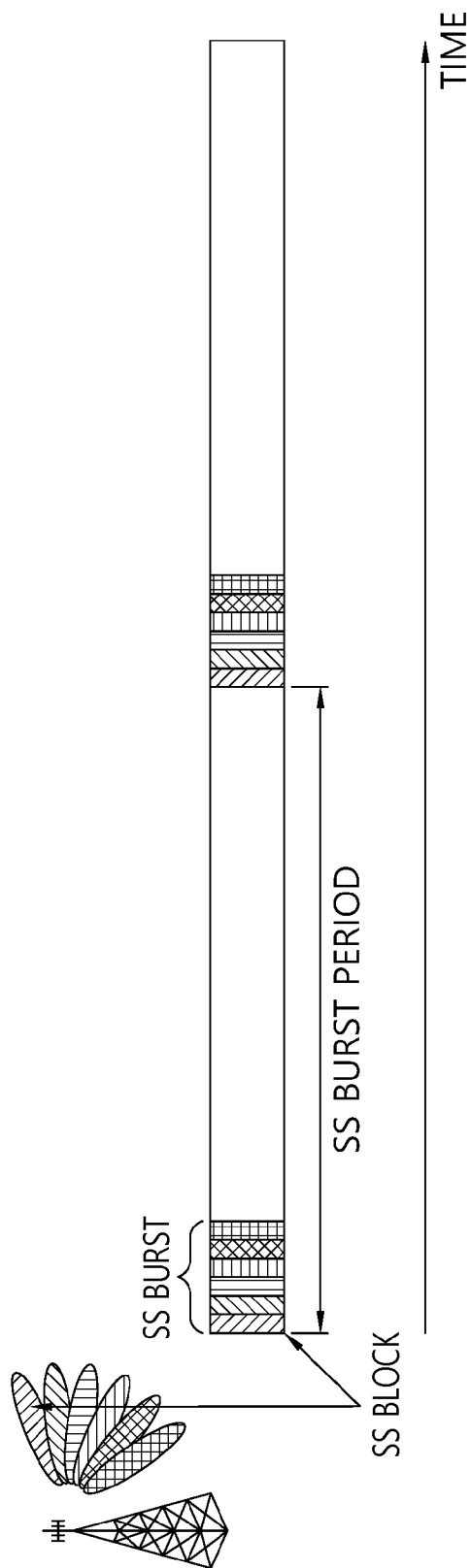
[Fig. 4c]



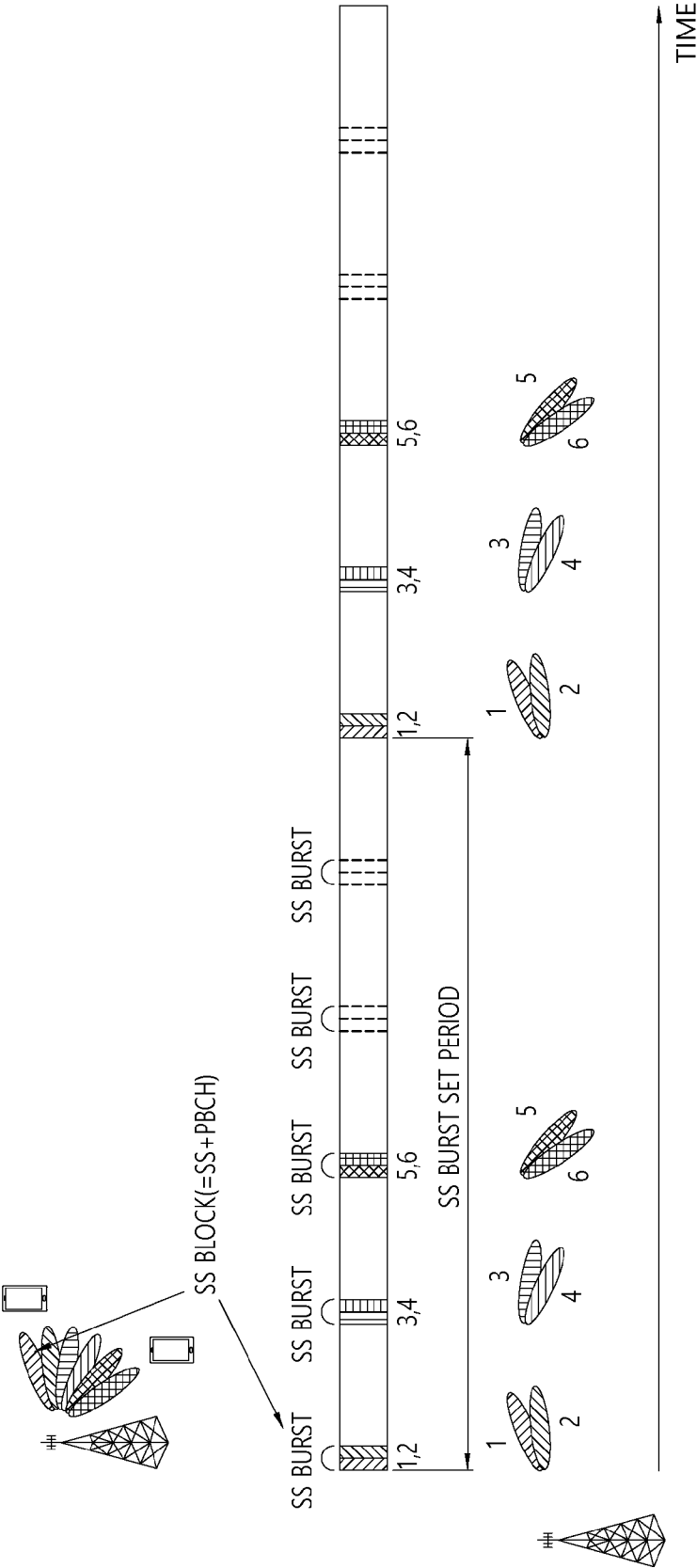
[Fig. 5]



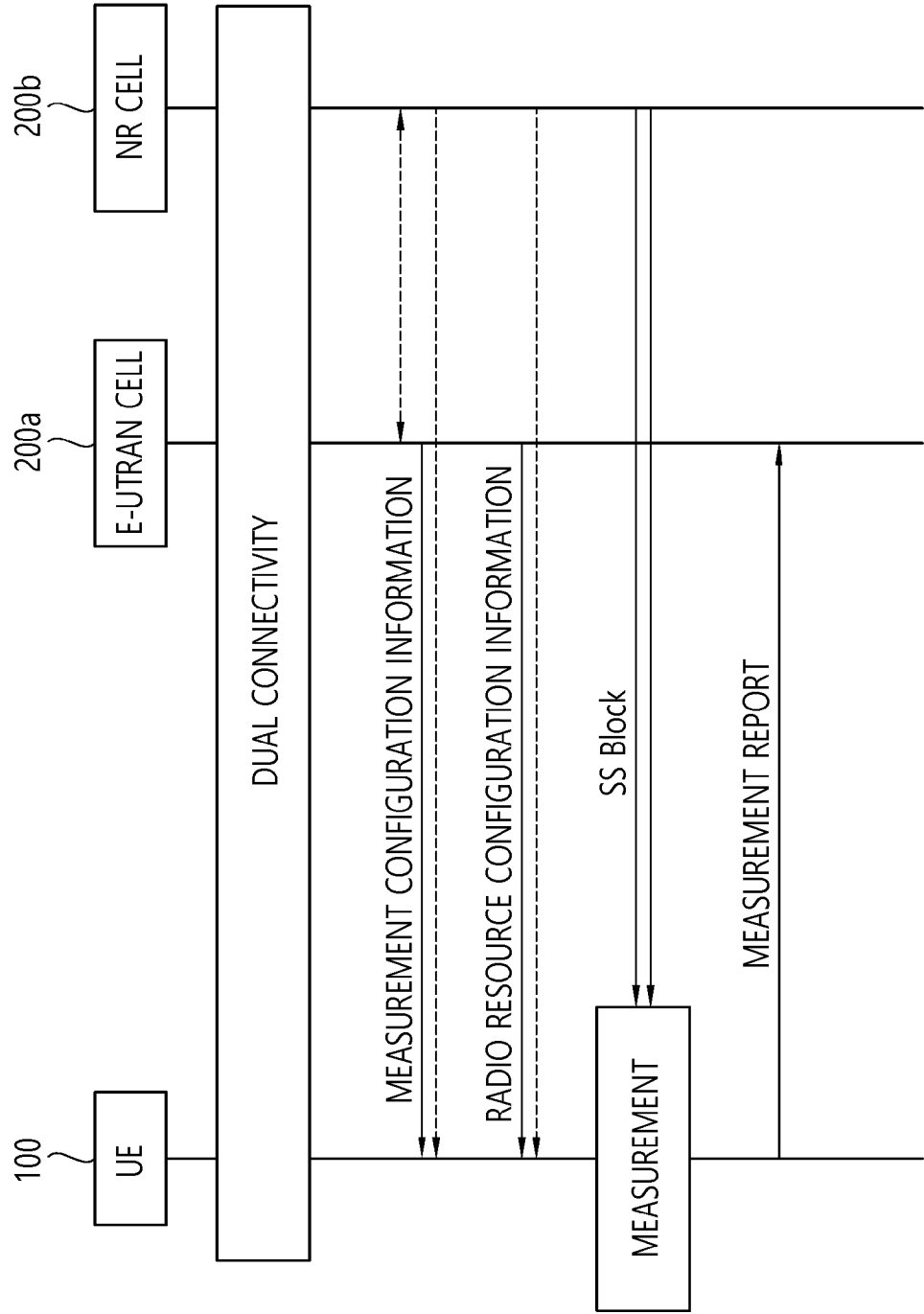
[Fig. 6]



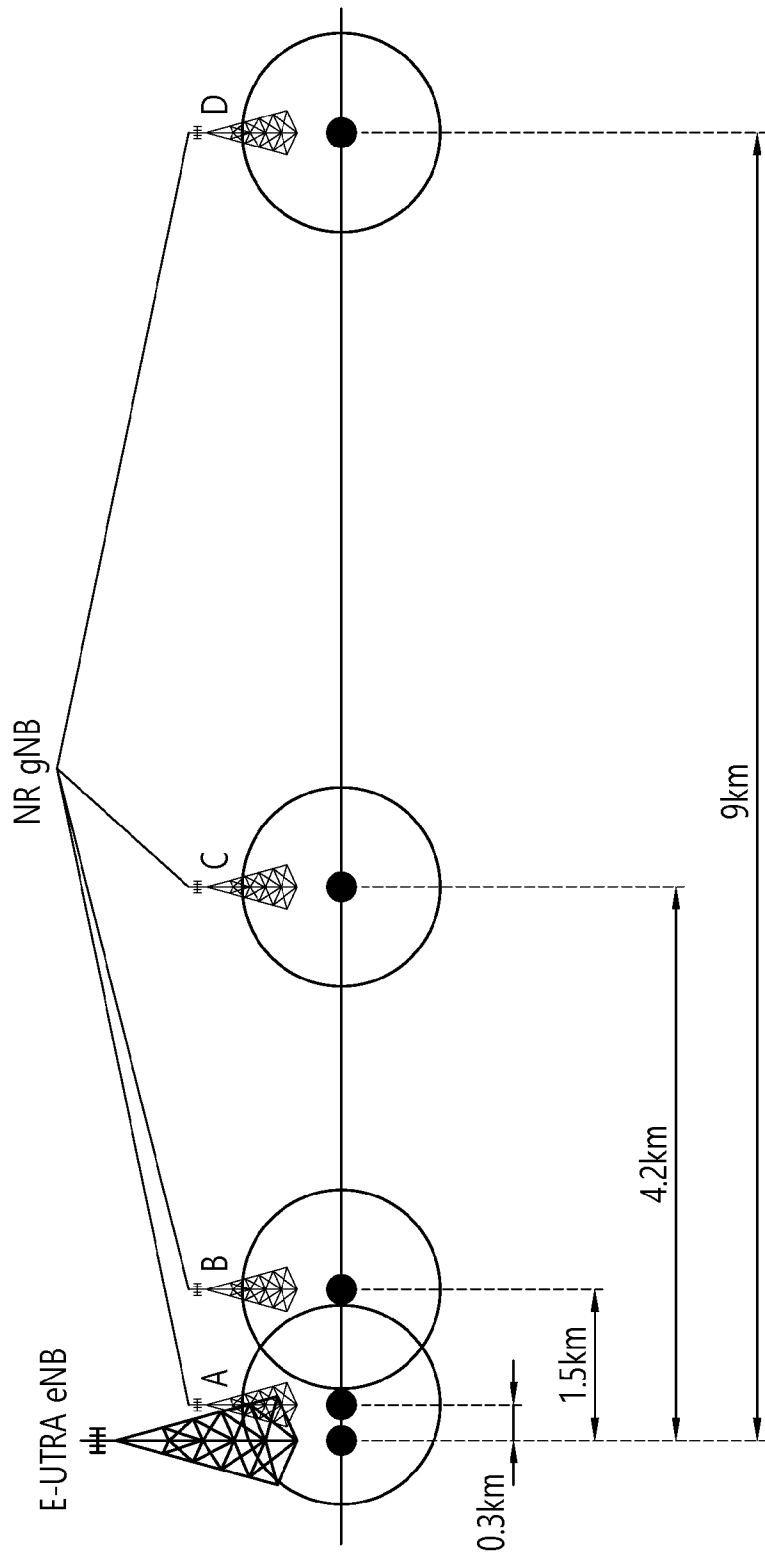
[Fig. 7]



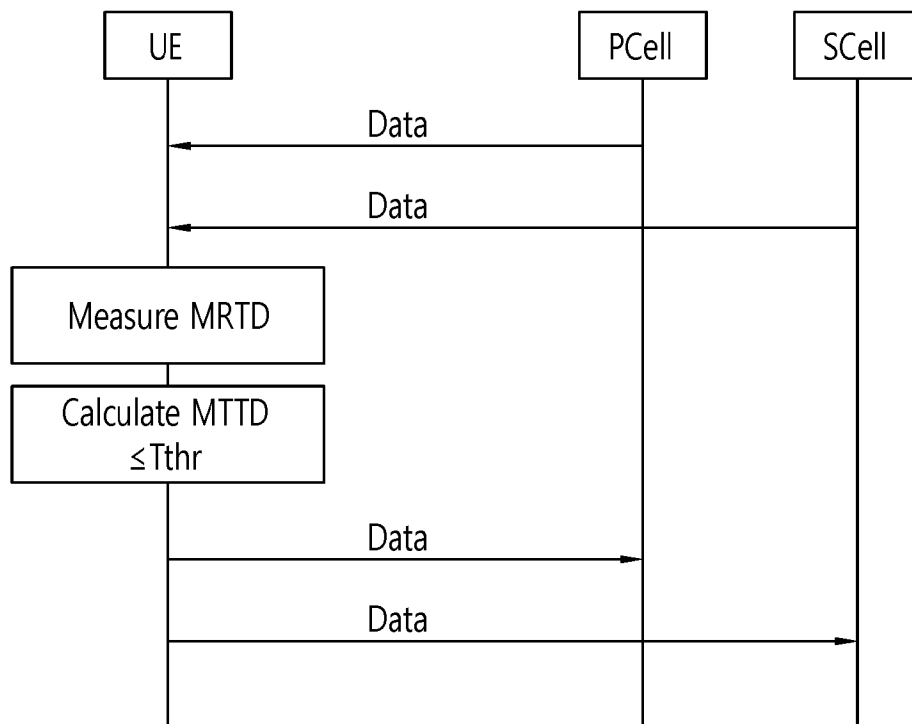
[Fig. 8]



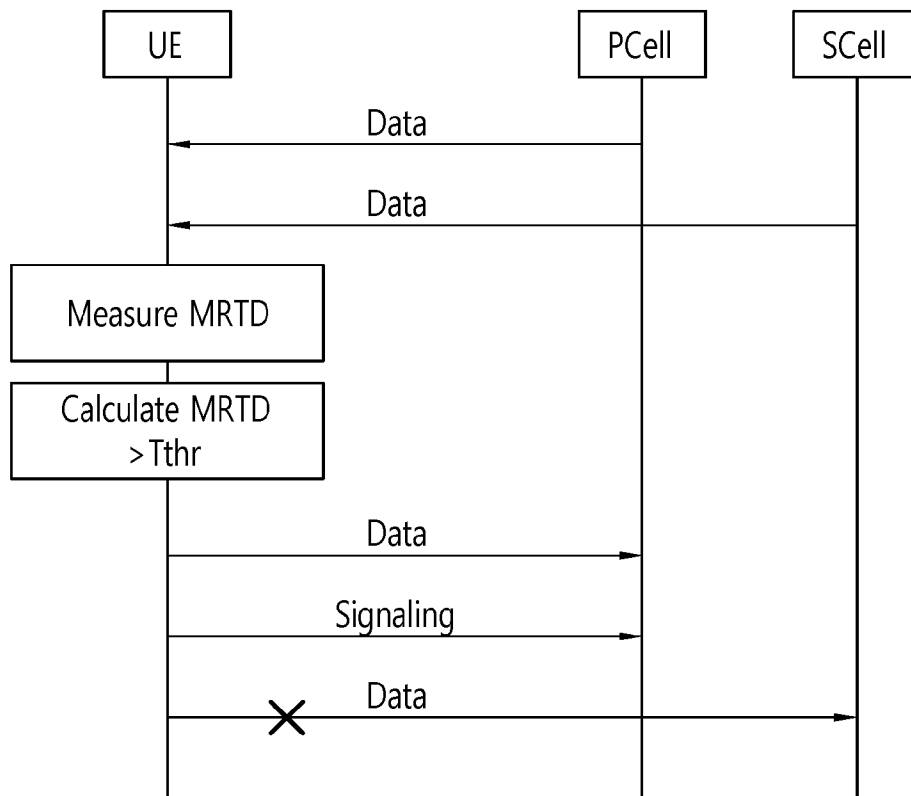
[Fig. 9]



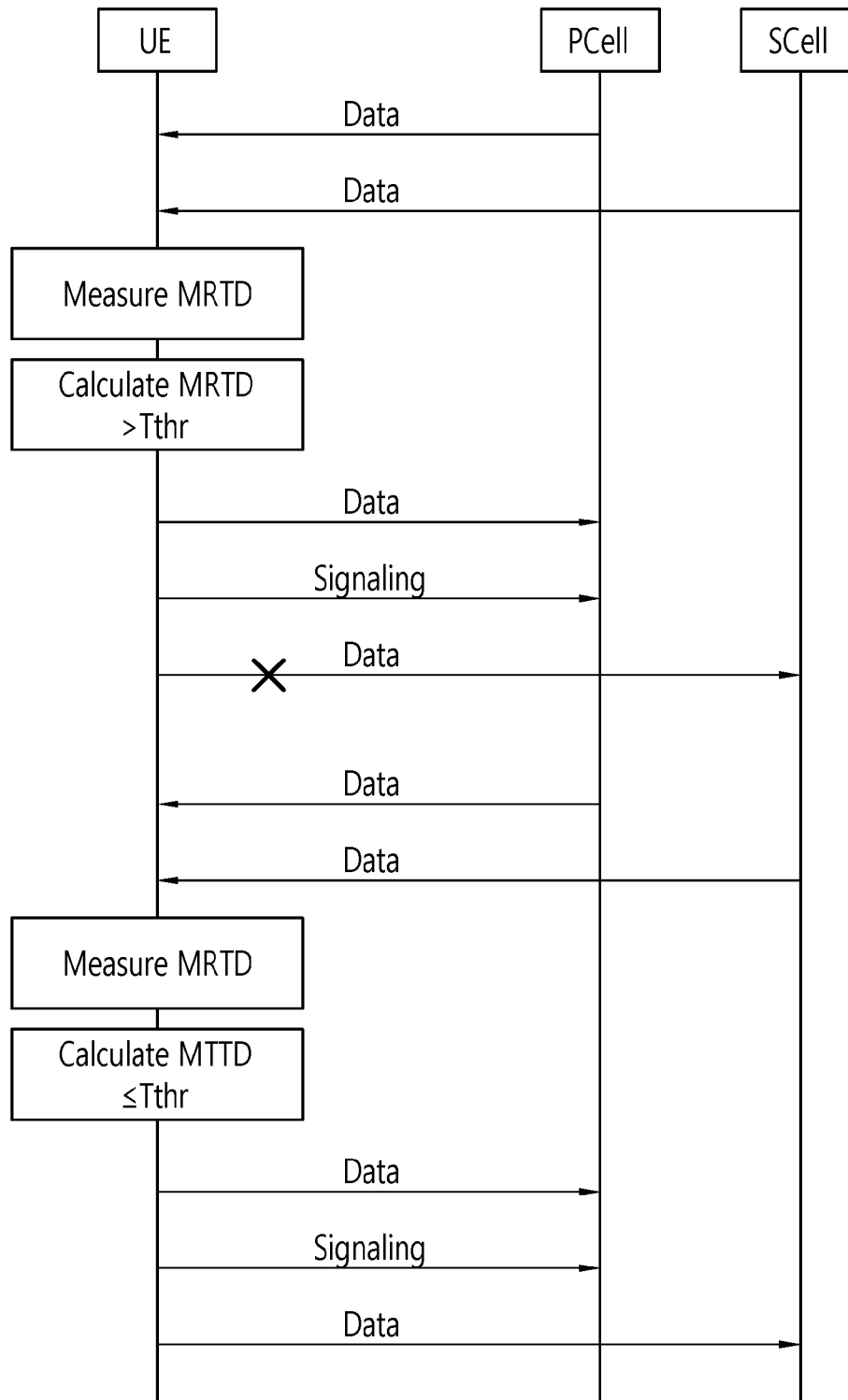
[Fig. 10a]



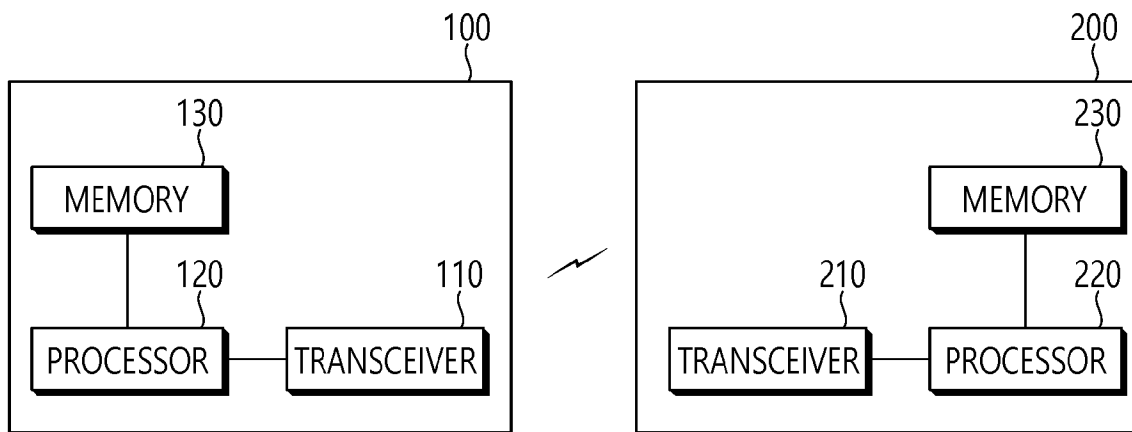
[Fig. 10b]



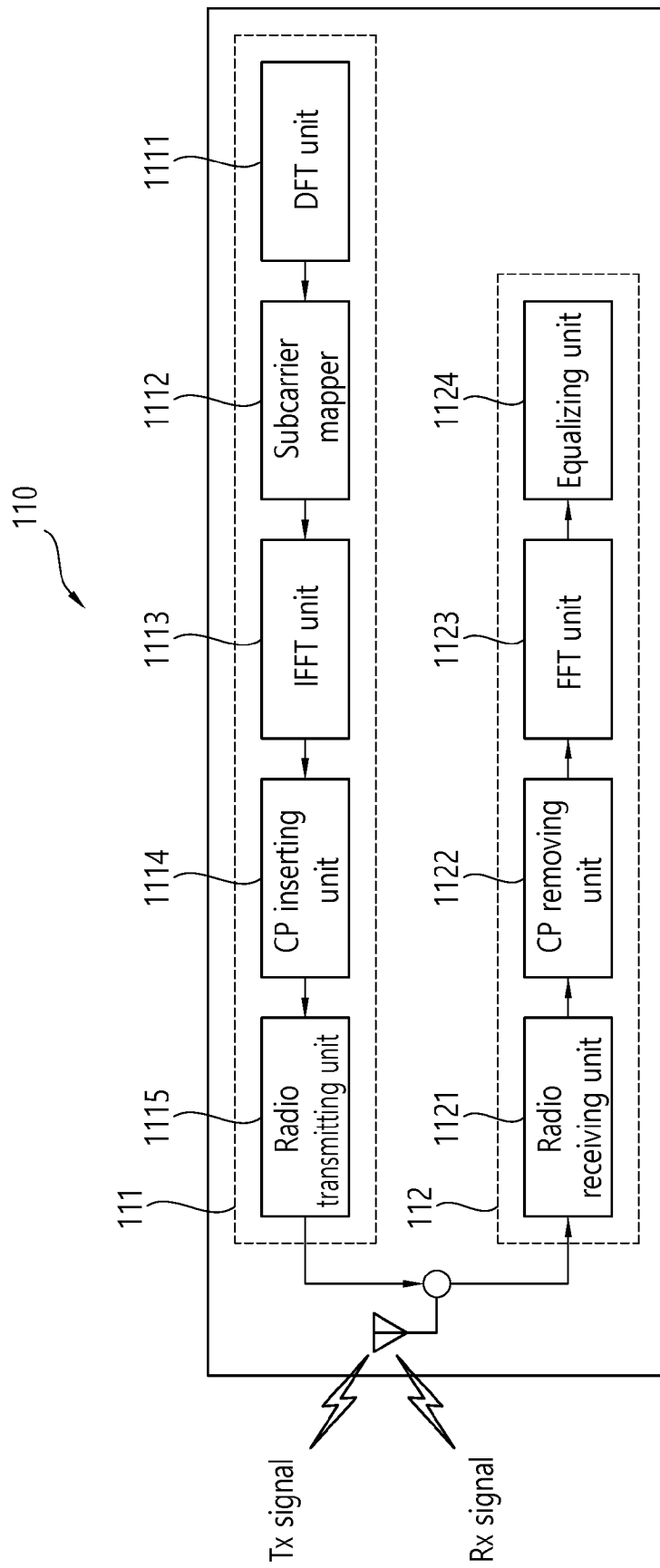
[Fig. 10c]



[Fig. 11]



[Fig. 12]



A. CLASSIFICATION OF SUBJECT MATTER**H04W 56/00(2009.01)i**

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

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
H04W 56/00Documentation 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 modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: maximum transmission timing difference (MTTD), maximum receive timing difference (MRTD), subcarrier spacings (SCSs), UL, DL**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ERICSSON `Draft pCR to TS 38.133 v15.0.0: Additional synch/synch requirement for NR DC', R4-1800598, 3GPP TSG RAN WG4 Ad Hoc #1801, San Diego, California, US, 15 January 2018 See pages 1-4 and tables 7.5.2-2, 7.6.2-2.	1-15
A	INTEL CORPORATION, `Discussions on MRTD and MTTD for synchronous DC in Rel-15 LTE-NR combinations', R4-1800145, 3GPP TSG RAN WG4 Ad Hoc #1801, San Diego, US, 15 January 2018 See sections 1-4.	1-15
A	CATT, `Further discussion on MTTD and MRTD for EN-DC', R4-1800052, 3GPP TSG RAN WG4 Ad Hoc #1801, San Diego, US, 15 January 2018 See sections 1-3.	1-15
A	CATT et al., `WF on MTTD and MRTD requirements for synchronous EN-DC and NR CA', R4-1801300, 3GPP TSG RAN WG4 Ad Hoc #1801, San Diego, US, 29 January 2018 See slides 1-8.	1-15
A	LG ELECTRONICS, `TP on TS38.133 Section 7.5 MTTD and 7.6 MRTD in E-UTRA-NR DC', R4-1713947, 3GPP TSG RAN WG4 #85, Reno, USA, 05 December 2017 See section 2.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

03 May 2019 (03.05.2019)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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None