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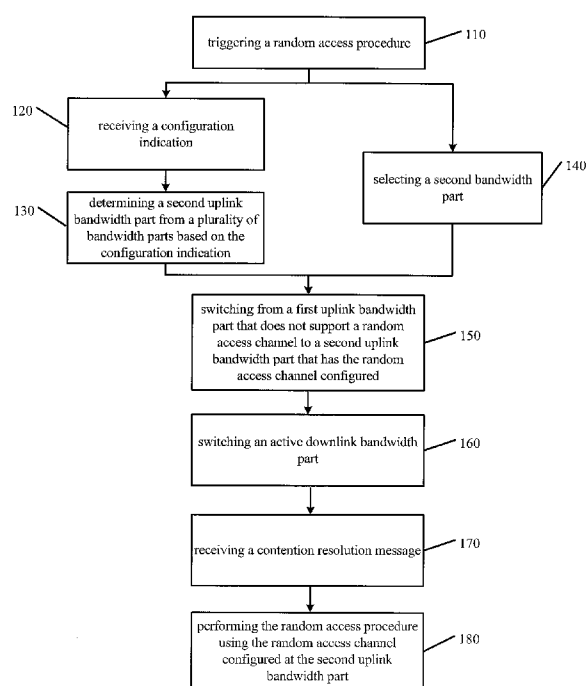


Figure 1

(57) Abstract: Various communication systems may benefit from improved random access operations. For example, certain embodiments may benefit from improved random access in which multiple bandwidth parts are configured to a user equipment within one cell. A method, in certain embodiments, may include triggering a random access procedure at a user equipment. The method may also include switching at the user equipment from a first uplink bandwidth part that does not support a random access channel to a second uplink bandwidth part that has the random access channel configured after the triggering of the random access procedure. The switching may be autonomously performed by the user equipment. In addition, the method may include performing the random access procedure at the user equipment using the random access channel configured at the second uplink bandwidth part.

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## RANDOM ACCESS WITH BANDWIDTH PART SWITCH

### BACKGROUND:

#### 5 Field:

[0001] Various communication systems may benefit from improved random access operations. For example, certain embodiments may benefit from improved random access in which multiple bandwidth parts are configured to a user equipment within one cell.

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#### Description of the Related Art:

[0002] In Third Generation Partnership Project (3GPP) technology, such as Long Term Evolution (LTE) and LTE Advanced (LTE-A), a user equipment (UE) can begin accessing network services once the UE is synchronized with the network.

15 Random access procedure is generally used to synchronize the UE with the network in the uplink direction via a physical random access channel (PRACH). The random access procedure may be either a contention-based random access procedure or a non-contention/contention-free random access procedure.

[0003] A contention-based random access procedure may be used when multiple  
20 UEs attempt to simultaneously access the network. The contention-based random access procedure may be used to resolve the potential collisions between the multiple UEs, while also synchronizing the UEs with the network. This contention-based random access procedure may include four separate messages transmitted between the UE and the network. The UE initially sends a first  
25 message with a random access channel preamble that includes a random access radio network temporary identity (RA-RNTI). The network entity then decodes the received RA-RNTI, and responds by transmitting a random access response in a second message. The random access response generally includes a temporary cell radio network temporary identity (C-RNTI), a timing advance value, and an uplink

grant resource.

[0004] The UE uses that timing advance value to synchronize with the network, and transmits a radio resource control (RRC) connection request using the temporary C-RNTI, in a third message. The UE also includes a random value or a  
5 temporary mobile subscriber identity (TMSI) in the third message, which may be used by the network to determine a new C-RNTI, in case the temporary C-RNTI was assigned to multiple UEs. The network entity may then respond with a contention resolution message or an RRC connection setup message that includes the new C-RNTI. The new C-RNTI will be used by both the UE and the network  
10 entity to exchange data with one another for as long as the UE remains in a connected RRC state.

[0005] A system bandwidth in a given cell, which is used for both downlink and uplink transmissions by the network entity and UE, may be divided into one or more bandwidth parts. For a paired spectrum the downlink and uplink bandwidth  
15 parts (BWPs) are configured separately and independently for a UE in each serving cell. A paired spectrum is characterized by a block of spectrum in a lower frequency band that is associated with a block of spectrum in an upper frequency band using Frequency Division Duplex (FDD). For an unpaired spectrum that utilizes a Time Division Duplex (TDD), on the other hand, downlink BWPs and  
20 uplink BWPs are jointly configured as a pair, while sharing the same center frequency.

[0006] In a primary cell, for example, the random access channel can be configured on each uplink BWP, and each downlink BWP has to have a common search space (CSS) for the random access response. If some BWPs of the primary  
25 cell is not configured with RACH, at least the initial BWP will support the random access channel. In 3GPP fifth generation (5G) or New Radio (NR) technology, the number of scheduling requests may be counted. When the number of scheduling requests is equal to or exceeds a scheduling request transmission maximum, the user equipment may initiate a random access procedure, similar to the LTE or

LTE-A.

## SUMMARY

[0007] According to certain embodiments, an apparatus may include at least one memory including computer program code, and at least one processor. The at least one memory and the computer program code may be configured, with the at least one processor, to cause the apparatus at least to trigger a random access procedure at a user equipment. The at least one memory and the computer program code may also be configured, with the at least one processor, to cause the apparatus at least to switch from a first uplink bandwidth part that does not support a random access channel to a second uplink bandwidth part that has the random access channel configured after the triggering of the random access procedure. The switch may be autonomously performed by the apparatus. In addition, the at least one memory and the computer program code may be configured, with the at least one processor, to cause the apparatus at least to perform the random access procedure using the random access channel configured at the second uplink bandwidth part.

[0008] A method, in certain embodiments, may include triggering a random access procedure at a user equipment. The method may also include switching at the user equipment from a first uplink bandwidth part that does not support a random access channel to a second uplink bandwidth part that has the random access channel configured after the triggering of the random access procedure. The switching may be autonomously performed by the user equipment. In addition, the method may include performing the random access procedure at the user equipment using the random access channel configured at the second uplink bandwidth part.

[0009] An apparatus, in certain embodiments, may include means include triggering a random access procedure at a user equipment. The apparatus also includes means for switching at the user equipment from a first uplink bandwidth part that does not support a random access channel to a second uplink bandwidth

part that has the random access channel configured after the triggering of the random access procedure. The switching may be autonomously performed by the user equipment. In addition, the apparatus may include means for performing the random access procedure at the user equipment using the random access channel  
5 configured at the second uplink bandwidth part.

**[0010]** According to certain embodiments, a non-transitory computer-readable medium encoding instructions that, when executed in hardware, perform a process. The process may include triggering a random access procedure at a user equipment. The process may also switching at the user equipment from a first uplink  
10 bandwidth part that does not support a random access channel to a second uplink bandwidth part that has the random access channel configured after the triggering of the random access procedure. The switching may be autonomously performed by the user equipment. In addition, the process may include performing the random access procedure at the user equipment using the random access channel  
15 configured at the second uplink bandwidth part.

**[0011]** According to certain other embodiments, a computer program product may encode instructions for performing a process. The process may include triggering a random access procedure at a user equipment. The process may also switching at the user equipment from a first uplink bandwidth part that does not support a  
20 random access channel to a second uplink bandwidth part that has the random access channel configured after the triggering of the random access procedure. The switching may be autonomously performed by the user equipment. In addition, the process may include performing the random access procedure at the user equipment using the random access channel configured at the second uplink  
25 bandwidth part.

#### BRIEF DESCRIPTION OF THE DRAWINGS:

**[0012]** For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

[0013] Figure 1 illustrates an example of a flow diagram according to certain embodiments.

[0014] Figure 2 illustrates an example of a system according to certain embodiments.

5

#### DETAILED DESCRIPTION:

[0015] Certain embodiments may include beam failure detection. When beam failure is detected, the UE may transmit a beam recovery request. The beam recovery request may be triggered or initiated when the number of consecutive  
10 detected beam failure instances exceeds a given threshold. The threshold, for example, may be defined as a block error rate (BLER). Some embodiments may have either one or more thresholds. In a multiple threshold embodiment, for example, one threshold may be directed to the synchronization signal block (SSB), while the other threshold may be for channel state information reference signal  
15 (CSI-RS). In NR technology, a network entity, such as a 5G or NR NodeB (gNB), may uniquely identify the user equipment from a beam failure recovery request using a PRACH sequence provided to UE by the network.

[0016] In order to determine dedicated PRACH resources for beam failure recovery, certain parameters related to the UE may be configured. For example,  
20 preamble sequence related parameters, such as a root sequence, cyclic shift, and/or a preamble index may be set. In another example, the maximum number of transmissions, maximum number of power rampings, target received power, retransmission power ramping step size, and/or a beam failure recovery timer of the UE may be configured. In some embodiments, dedicated PRACH resource  
25 parameters may also be configured. For example, frequency location information, time location, and/or associated SSB or CSI-RS information. When the beam failure triggering is met, the UE may transmit a dedicated PRACH preamble to recover the link via a random access procedure.

[0017] In some embodiments, only a subset of the total uplink bandwidth parts

may support a random access procedure via a PRACH, also referred to as a random access channel (RACH) hereinafter. The UE may therefore be restricted to performing random access procedures towards a primary cell (PCell) or a primary secondary cell (PSCell) in only a subset of uplink bandwidth parts. Certain  
5       embodiments may allow a UE in an RRC connected mode to deal with the UE based triggers for random access procedure when the network is not aware of such an event. In other words, the UE may be allowed to autonomously trigger a random access procedure, even if the current active BWP, which may be referred to as a first uplink BWP, does not support a random access channel.

10       **[0018]** For example, when the random access procedure is triggered by the UE, and the currently active BWP does not support a random access channel, certain embodiments allow the UE to autonomously switch to another uplink BWP, which may be referred to as a second uplink BWP, that has the random access channel configured. The UE autonomously performing the switch may mean that the  
15       switch may be performed without any knowledge or involvement from the network. Because the current active BWP does not support and/or is not configured for a RACH, the network may not be aware that the UE is attempting to initiate a random access procedure. The first uplink BWP and the second uplink BWP may be different.

20       **[0019]** Figure 1 illustrates an example of a flow diagram according to certain embodiments. In particular, Figure 1 illustrates an example of a user equipment performing a method or process. In step 110, the UE may trigger a random access procedure. The random access procedures may be triggered via a RACH. The UE may be in a RRC connected state during the triggering of the random access  
25       procedure. As shown in step 150, the UE may switch from a first uplink BWP that does not support a random access channel to a second uplink BWP that has the random access channel configured. In other words, the second uplink BWP may already have a configured RACH.

**[0020]** In certain embodiments, in which multiple uplink BWPs support a random

access channel, a network entity, such as gNB, may determine in which uplink BWP the UE should initiate the random access channel. The plurality of BWPs may be configured to the UE within a single cell. The network entity may, for example, be included in a PCell or a PSCell. The network entity may transmit the determination of the uplink BWP to the UE as part of a configuration indication. As shown in step 120, the UE may receive a configuration indication from the network entity. Based on the configured indication, the UE may select the second uplink BWP from a plurality of BWPs, as shown in step 130. In some other embodiments, the UE may receive the configuration information from the network entity, as shown in step 120, before the triggering of the random access procedure in step 110.

**[0021]** In other embodiments, the another or the second uplink bandwidth part may be determined by the UE, without an indicated configuration from the network entity, as shown in step 140. For example, the second uplink bandwidth part may be determined by the UE based on at least one of a numerology and/or a frequency of the random access channel. Numerology may be a subcarrier spacing. NR technology supports multiple numerology options related to multiple subcarrier spacing. The subcarrier spacing may be, for example, 15, 30, 60, 120, and 240 kilohertz (kHz). The UE may determine the second BWP based on any of the above multiple numerology options and/or a frequency utilized by the BWP. In some embodiments, the UE may be configured at least with a default BWP from the plurality of BWPs. The UE may determine the second BWP based on whether it is a default BWP.

**[0022]** As discussed above, in step 140 the user equipment selects the second uplink BWP. In some embodiments, the second BWP may be selected based on an implementation of the UE and/or selected based on a default and/or an initial BWP. The default and/or initial BWP may be configured for other purposes, such as power saving, and may be used as a fall back for the RACH. A selection based on the implementation of the UE may mean that it is up to the UE implementation to

select a BWP of the cell that has a RACH configured. In yet another embodiment, the UE may select the second BWP based on a logical channel that triggers the random access procedure, or a priority of the logical channel. For example, some logical channels may be restricted to be mapped to an uplink channel with certain subcarrier spacing, and hence a BWP with a RACH supporting the certain  
5 subcarrier spacing to which the logical channel is restricted may be prioritized.

[0023] Once the second BWP part is selected, as shown in step 140, the user equipment may switch equipment from a first uplink bandwidth part that does not support a random access channel to second uplink bandwidth part that has the random access channel configured, as shown in step 150. The switch from the first uplink bandwidth part to the second uplink bandwidth part may be autonomously performed by the user equipment. In some embodiments, the network may not even be aware that the UE is performing random access procedure. The switching illustrated in step 150 may include the UE autonomously deactivating the first  
10 uplink BWP and activating the second uplink BWP.

[0024] In certain embodiments, one or more uplink carriers may share the same uplink timing alignment, and may be grouped together within the same Timing Advance Group (TAG). In order to prevent the UE from transmitting any uplink signals other than the ones related to the random access procedure, time alignment timer (TAT) may be considered expired. In some embodiments, the TAT may be associated with a TAG that includes the first BWP and the second BWP. In other words, to prevent the transmitting of any signals on the first BWP, the TAT associated with the TAG comprising the first BWP and/or the second BWP may be considered expired. The UE may therefore not be able to transmit any signals on  
20 the first BWP until it receives a new timing advance value from the network. The new timing advance value may be received through random access procedure upon which the timing alignment timer is started again. The signals the UE may attempt to transmit on the first BWP, for example, may be in response to a downlink assignment or an uplink grant received at the UE from a network entity that is

unaware of the ongoing random access procedure.

[0025] In step 160, the UE may switch an active downlink BWP together with the switching from the first uplink bandwidth part to the second uplink bandwidth part shown in step 150. For example, when the triggered random access procedure is a contention-based random access procedure, an active downlink BWP is switched together with the switching from the first uplink BWP to the second uplink BWP. The contention-based random access procedure may be triggered, for example, when reaching a maximum number of scheduling requests in the Medium Access Control (MAC) layer. The switching of the active downlink BWP together with the second uplink BWP may be performed so that the downlink BWP may correspond to the BWP in which the UE expects to receive the random access response from the network entity. Because the network may not be able to identify the UE from the received preamble, the random access response may need to be transmitted in a known downlink BWP. Such a downlink BWP may be at least one of the downlink BWPs having a CSS.

[0026] On the other hand, certain embodiments may utilize a contention-free random access procedure. This random access procedure, for example, may be triggered after a beam failure being detected by the UE, or after a beam recovery request is transmitted by the UE. In the contention-free random access procedure, the UE may switch an active downlink BWP together with the switching of the first uplink bandwidth part to the second uplink bandwidth part, similar to the contention-based random access procedure. In other embodiments, however, the UE may retain the current downlink BWP in a contention-free random access procedure, regardless of the first uplink BWP is switched.

[0027] In certain embodiments, whether the UE will switch or retain the downlink BWP in a contention-free random access procedure may be configured by the network or a network entity therein. The network, in such embodiments, may identify the UE from the received preamble, and may be able to respond in an earlier downlink BWP. Some embodiments, in which the network determines the

retaining or the switching of the downlink BWP, may be used in a paired spectrum where the downlink and uplink BWPs are independently configured or switched. In some embodiments, the earlier downlink BWP may have a CSS, while in some other embodiments of the earlier downlink BWP may only have a UE-specific search space (USS).

[0028] In step 170, the UE may receive a contention resolution message from a network entity as part of the random access procedure. The contention resolution message is the fourth message in the contention-based random access procedure. The switching of at least one of the uplink BWP and/or the downlink BWP may occur upon the receiving of the contention resolution message at the UE. In some embodiments, the contention resolution message is transmitted addressed directly to the UE's C-RNTI, in which case the switching of at least one of the uplink BWP and/or the downlink BWP may be enforced. In step 180, the UE may perform the random access procedure using the random access channel configured at the second uplink bandwidth part. The embodiments discussed help to prevent erroneous network scheduling when the UE has already triggered a random access procedure. This will reduce the amount of resources used by the network, thereby improving the functioning of the network as a whole, and the network entities included within the network.

[0029] Figure 2 illustrates a system according to certain embodiments. It should be understood that each block in Figure 1 may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry. In one embodiment, a system may include several devices, such as, for example, a network entity 220 or a UE 210. The system may include more than one UE 210 and more one network entity 220, although only one network entity is shown for the purposes of illustration. The network entity may be a network node, an access node, a base station, an evolved NodeB (eNB), a gNB, a server, a host, or any of the other access or network node discussed herein.

[0030] Each of these devices may include at least one processor or control unit or module, respectively indicated as 211 and 221. At least one memory may be provided in each device, and indicated as 212 and 222, respectively. The memory may include computer program instructions or computer code  
5 contained therein. One or more transceiver 213 and 223 may be provided, and each device may also include an antenna, respectively illustrated as 214 and 224. Although only one antenna each is shown, many antennas and multiple antenna elements may be provided to each of the devices. Higher category UEs generally include multiple antenna panels. Other configurations of these devices, for  
10 example, may be provided. For example, network entity 220 and UE 210 may be additionally configured for wired communication, in addition to wireless communication, and in such a case antennas 214 and 224 may illustrate any form of communication hardware, without being limited to merely an antenna.

[0031] Transceivers 213 and 223 may each, independently, be a transmitter, a  
15 receiver, or both a transmitter and a receiver, or a unit or device that may be configured both for transmission and reception. In other embodiments, the UAVs or the network entity may have at least one separate receiver or transmitter. The transmitter and/or receiver (as far as radio parts are concerned) may also be implemented as a remote radio head which is not located in the  
20 device itself, but in a mast, for example. The operations and functionalities may be performed in different entities, such as nodes, hosts or servers, in a flexible manner. In other words, division of labor may vary case by case. One possible use is to make a network node deliver local content. One or more functionalities may also be implemented as virtual application(s) in software that can run on a  
25 server.

[0032] A user device or user equipment may be a mobile station (MS) such as a mobile phone or smart phone or multimedia device, a computer, such as a tablet, provided with wireless communication capabilities, personal data or digital assistant (PDA) provided with wireless communication capabilities, portable

media player, digital camera, pocket video camera, navigation unit provided with wireless communication capabilities or any combinations thereof. In other embodiments, the UE may be a machine type communication (MTC) device or an Internet of Things device, which may not require human interaction, such as a sensor, a meter, or an actuator. The method and/or process illustrated in Figure 1 may be performed by user equipment 210.

**[0033]** In some embodiments, an apparatus, such as user equipment 210 or network entity 220, may include means for carrying out embodiments described above in relation to Figure 1. In certain embodiments, at least one memory including computer program code can be configured to, with the at least one processor, cause the apparatus at least to perform any of the processes described herein. The apparatus, for example, may be user equipment 210 or network entity 220.

**[0034]** Processors 211 and 221 may be embodied by any computational or data processing device, such as a central processing unit (CPU), digital signal processor (DSP), application specific integrated circuit (ASIC), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), digitally enhanced circuits, or comparable device or a combination thereof. The processors may be implemented as a single controller, or a plurality of controllers or processors.

**[0035]** For firmware or software, the implementation may include modules or unit of at least one chip set (for example, procedures, functions, and so on). Memories 212 and 222 may independently be any suitable storage device, such as a non-transitory computer-readable medium. A hard disk drive (HDD), random access memory (RAM), flash memory, or other suitable memory may be used. The memories may be combined on a single integrated circuit as the processor, or may be separate therefrom. Furthermore, the computer program instructions may be stored in the memory and which may be processed by the processors can be any suitable form of computer program code, for example, a

compiled or interpreted computer program written in any suitable programming language. The memory or data storage entity is typically internal but may also be external or a combination thereof, such as in the case when additional memory capacity is obtained from a service provider. The memory may be fixed or  
5 removable.

[0036] The memory and the computer program instructions may be configured, with the processor for the particular device, to cause a hardware apparatus such as network entity 220 or UE 210, to perform any of the processes described above (see, for example, Figure 1). Therefore, in certain embodiments, a  
10 non-transitory computer-readable medium may be encoded with computer instructions or one or more computer program (such as added or updated software routine, applet or macro) that, when executed in hardware, may perform a process such as one of the processes described herein. Computer programs may be coded by a programming language, which may be a high-level  
15 programming language, such as objective-C, C, C++, C#, Java, etc., or a low-level programming language, such as a machine language, or assembler. Alternatively, certain embodiments may be performed entirely in hardware.

[0037] Furthermore, although Figure 2 illustrates a system including a network entity 220 and UE 210, certain embodiments may be applicable to other  
20 configurations, and configurations involving additional elements, as illustrated and discussed herein. For example, multiple user equipment devices and multiple network entities may be present, or other nodes providing similar functionality, such as nodes that combine the functionality of a user equipment and an network entity, such as a relay node. The UE 210 may likewise be  
25 provided with a variety of configurations for communication other than communication network entity 220. For example, the UE 210 may be configured for device-to-device, machine-to-machine, and/or vehicle-to-vehicle transmission.

[0038] The above embodiments may provide for significant improvements to the

functioning of a network and/or to the functioning of the user equipment and the network entities included within the network. Specifically, certain embodiments may allow a user equipment to perform a random access procedure, even when the active or first uplink BWP does not support a random access channel. The UE may  
5 switch the first uplink BWP to a second BWP that has the random access channel configured. Doing so will help to prevent errors in which the network may schedule a UE who already failed a scheduling request, and/or a UE that already triggered a random access procedure.

[0039] Preventing such erroneous scheduling will help to reduce the resources  
10 utilized by the network, thereby significantly improving the efficiency and throughput of the network as a whole. This improved efficiency will not only improve the functioning of the network entities included within the network, but will also significantly improve the functioning of the user equipment by preventing unnecessary transmissions. For example, reducing unnecessary transmissions with  
15 the network can help to reduce the amount of battery drained by the user equipment.

[0040] The features, structures, or characteristics of certain embodiments described throughout this specification may be combined in any suitable manner in one or more embodiments. For example, the usage of the phrases “certain  
20 embodiments,” “some embodiments,” “other embodiments,” or other similar language, throughout this specification refers to the fact that a particular feature, structure, or characteristic described in connection with the embodiment may be included in at least one embodiment of the present invention. Thus, appearance of the phrases “in certain embodiments,” “in some embodiments,” “in other  
25 embodiments,” or other similar language, throughout this specification does not necessarily refer to the same group of embodiments, and the described features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0041] One having ordinary skill in the art will readily understand that the

invention as discussed above may be practiced with steps in a different order, and/or with hardware elements in configurations which are different than those which are disclosed. Therefore, although the invention has been described based upon these preferred embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent, while remaining within the spirit and scope of the invention. Although many of the above embodiments are directed to 3GPP 5G or NR technology, the embodiments may apply to any other 3GPP technology, such as 4<sup>th</sup> generation (4G), 3<sup>rd</sup> generation (3G), LTE, LTE-A, and/or Internet of Things.

10 [0042] Partial Glossary

|           |         |                                                |
|-----------|---------|------------------------------------------------|
| [0043]    | 3GPP    | Third Generation Partnership Project           |
| [0044]    | 5G      | Fifth Generation                               |
| [0045]    | NR      | New Radio                                      |
| [0046]    | gNB     | NR Node B                                      |
| 15 [0047] | UE      | User Equipment                                 |
| [0048]    | LTE     | Long Term Evolution                            |
| [0049]    | LTE-A   | LTE Advanced                                   |
| [0050]    | PRACH   | Physical Random Access Channel                 |
| [0051]    | RA-RNTI | Random Access Radio Network Temporary Identity |
| 20 [0052] | C-RNTI  | Cell Radio Network Temporary Identity          |
| [0053]    | RRC     | Radio Resource Control                         |
| [0054]    | TMSI    | Temporary Mobile Subscriber Identity           |
| [0055]    | FDD     | Frequency Division Duplex                      |
| [0056]    | BWPs    | Bandwidth Parts                                |
| 25 [0057] | TDD     | Time Division Duplex                           |
| [0058]    | CSS     | Common Search Space                            |
| [0059]    | USS     | UE-specific Search Space                       |
| [0060]    | BLER    | Block Error Ratio                              |
| [0061]    | SSB     | Synchronization Signal Block                   |

|               |        |                                            |
|---------------|--------|--------------------------------------------|
| <b>[0062]</b> | CSI-RS | Channel State Information Reference Signal |
| <b>[0063]</b> | PCell  | Primary Cell                               |
| <b>[0064]</b> | PSCell | Primary Secondary Cell                     |
| <b>[0065]</b> | TAG    | Timing Advance Group                       |

**WHAT IS CLAIMED IS:**

1. A method comprising:  
triggering a random access procedure at a user equipment;  
switching at the user equipment from a first uplink bandwidth part that does  
5 not support a random access channel to a second uplink bandwidth part that has the  
random access channel configured after the triggering of the random access  
procedure, wherein the switching is autonomously performed by the user  
equipment; and  
performing the random access procedure at the user equipment using the  
10 random access channel configured at the second uplink bandwidth part.
2. The method according to claim 1, wherein the switching comprises the  
user equipment autonomously deactivating the first uplink bandwidth part and  
activating the second uplink bandwidth part.
- 15 3. The method according to claims 1 or 2, wherein a time alignment timer is  
considered expired.
4. The method according to claim 3, wherein the time alignment timer is  
20 associated with a time alignment group comprising at least one of the first uplink  
bandwidth part and the second uplink bandwidth part.
5. The method according to any of claims 1-4, further comprising:  
switching at the user equipment an active downlink bandwidth part together  
25 with the switching from the first uplink bandwidth part to the second uplink  
bandwidth part.
6. The method according to claim 5, wherein the switching of the first  
downlink bandwidth part occurs when the triggered random access procedure is at

least one of a contention-based random access procedure or a contention-free random access procedure.

7. The method according to any of claims 1-6, further comprising:

5 receiving at the user equipment a contention resolution message from a network entity as part of the random access procedure, wherein the switching of at least one of the first uplink bandwidth part or the downlink bandwidth part occurs upon the receiving of the contention resolution message.

10 8. The method according to any of claims 1-7, further comprising:

receiving a configuration indication at the user equipment from the network entity; and

selecting the second uplink bandwidth part from a plurality of bandwidth parts based on the configuration indication.

15

9. The method according to claim 8, wherein the plurality of bandwidth parts are configured to the user equipment within a single cell.

10. The method according to any of claims 1-9, further comprising:

20 selecting at the user equipment the second uplink bandwidth part based on at least one of an implementation of the user equipment, a default or an initial bandwidth part, a logical channel that triggers the random access procedure, or a priority of the logical channel.

25 11. The method according to any of claims 1-10, further comprising:

selecting by the user equipment the second uplink bandwidth part based on at least one of a numerology or a frequency of the random access channel.

12. The method according to any of claims 1-11, wherein the network entity

may be included in a primary cell or a secondary cell.

13. The method according to any of claims 1-12, wherein the user equipment is in a radio resource control connected state during the triggering of the  
5 random access procedure.

14. The method according to any of claims 1-13, wherein the triggering of the random access procedure occurs after a beam failure is detected by the user equipment.

10

15. An apparatus comprising:  
at least one processor; and  
at least one memory including computer program code,  
wherein the at least one memory and the computer program code are  
15 configured to, with the at least one processor, cause the apparatus at least to perform a process, the process comprising:  
trigger a random access procedure;  
switch from a first uplink bandwidth part that does not support a random access channel to a second uplink bandwidth part that has the random access  
20 channel configured after the triggering of the random access procedure, wherein the switching is autonomously performed by the apparatus; and  
perform the random access procedure using the second uplink bandwidth part.

25 16. The apparatus according to claim 15, wherein the switch comprises the apparatus autonomously deactivating the first uplink bandwidth part and activating the second uplink bandwidth part.

17. The apparatus according to claims 15 or 16, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to:

- 5       switch an active downlink bandwidth part together with the switching from the first uplink bandwidth part to the second uplink bandwidth part.

18. The apparatus according to any of claims 15-17, wherein the at least one memory and the computer program code are configured to, with the at least one  
10       processor, cause the apparatus at least to:

      receive a configuration indication from a network entity; and  
      select the second uplink bandwidth part from a plurality of bandwidth parts based on the configuration indication.

15       19. The apparatus according to any of claims 15-18, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to:

      select the second uplink bandwidth part based on at least one of an implementation of the apparatus, a default or an initial bandwidth part, a logical  
20       channel that triggers the random access procedure, or a priority of the logical channel.

20. The apparatus according to any of claims 15-19, wherein the apparatus is in a radio resource control connected state during the triggering of the random  
25       access procedure.

21. An apparatus comprising:

at least one processor; and

at least one memory including computer program code,

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to perform a process, the process including the method according to any of claims 3, 4, 6, 7, 9, and 11-14.

5

22. A non-transitory computer-readable medium encoding instructions that, when executed in hardware, perform a process, the process including the method according to any of claims 1-14.

10

23. An apparatus comprising means for performing a process, the process including the method according to any of claims 1-14.

24. A computer program product encoding instructions for performing a process, the process including the method according to any of claims 1-14.

15

25. A computer program product embodied in a non-transitory computer-readable medium and encoding instructions that, when executed in hardware, perform a process, the process including the method according to any of claims 1-14.

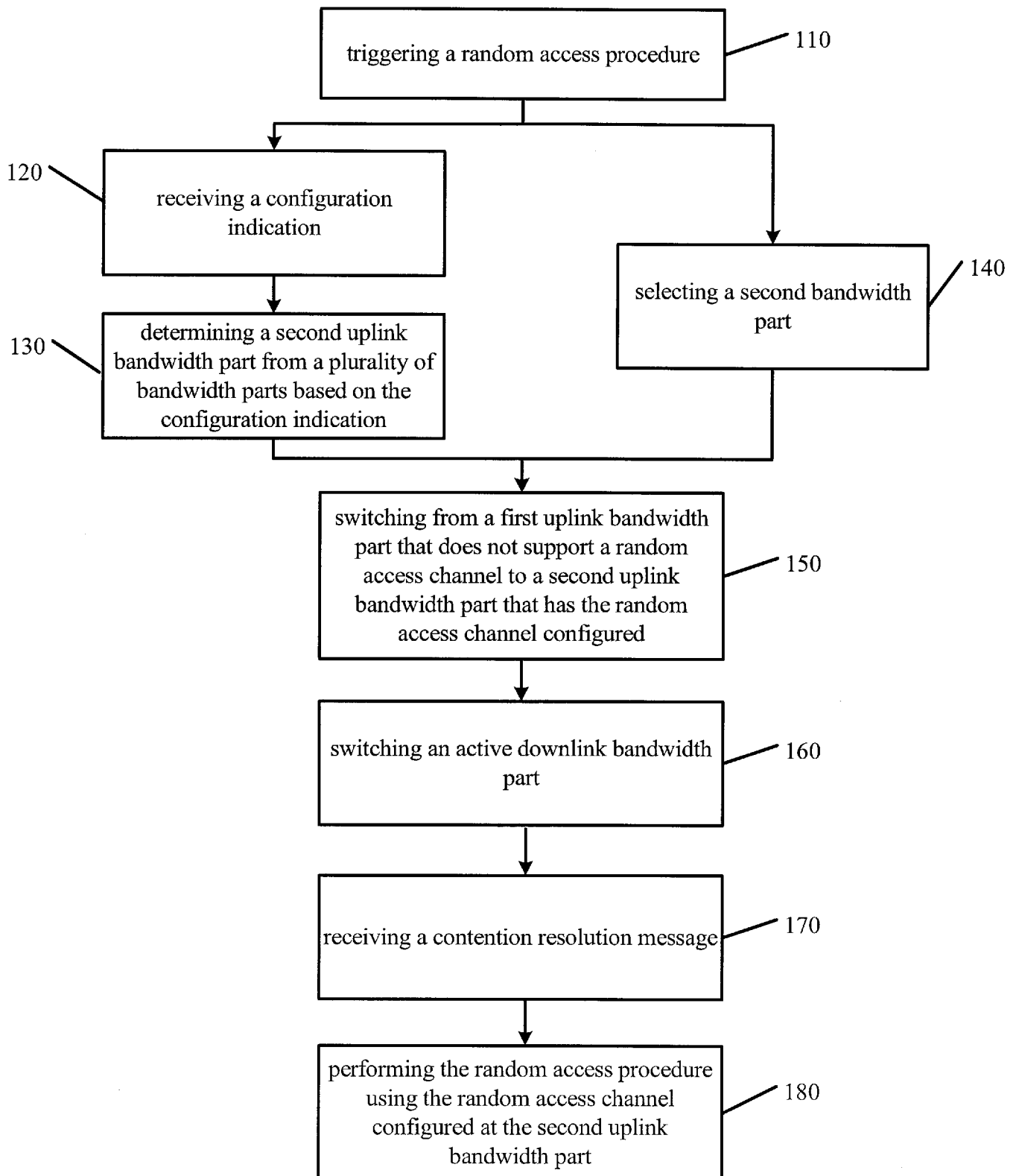


Figure 1

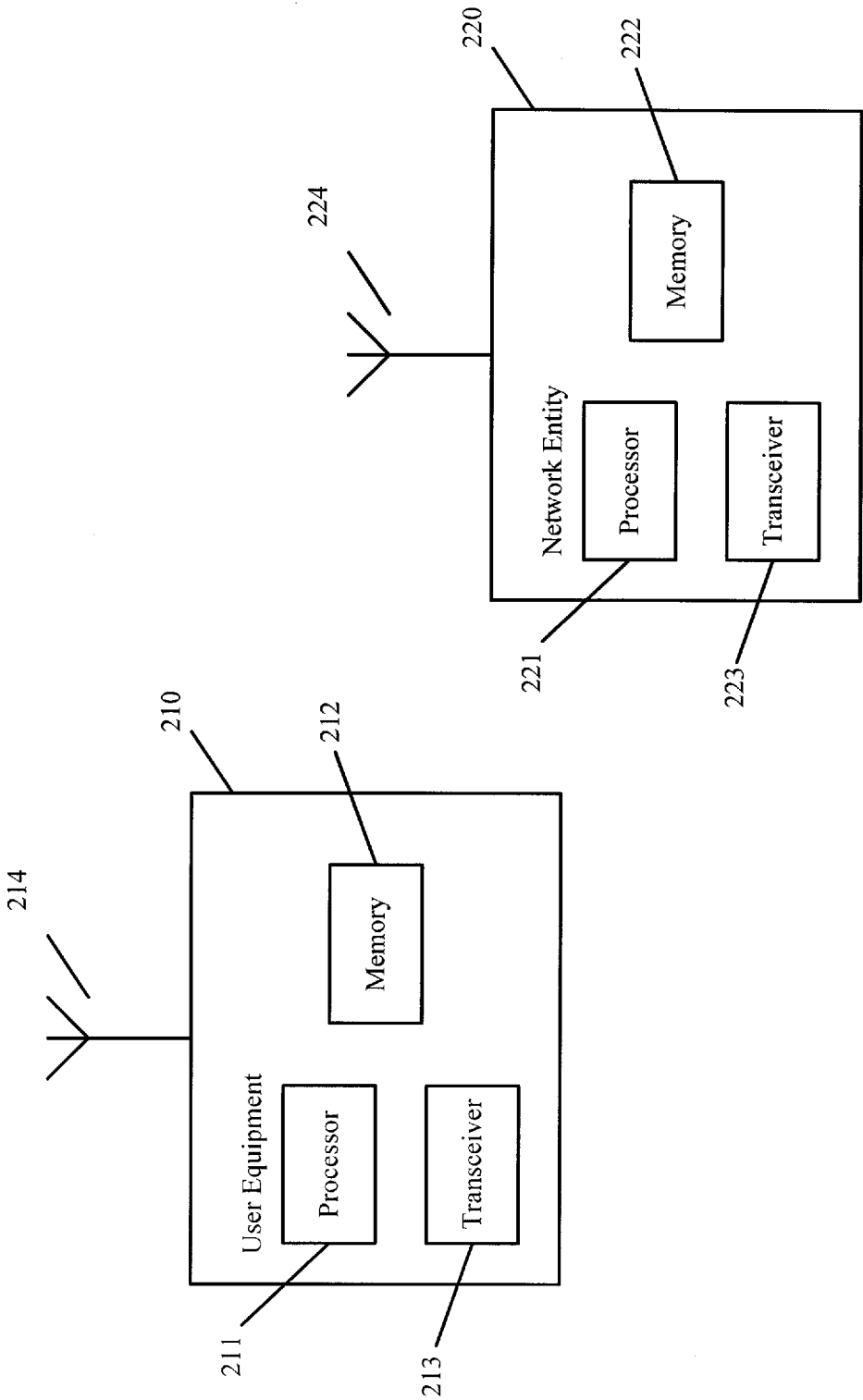


Figure 2

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/111143

| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>H04L 5/00(2006.01)i<br><br>According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
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| <b>B. FIELDS SEARCHED</b><br>Minimum documentation searched (classification system followed by classification symbols)<br>H04L<br><br>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched<br><br>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)<br>CNKI,CNPAT,WPI,EPODOC,3GPP:random, access, procedure, user, equipment, BWP, bandwidth, part, uplink, downlink, channel>window, response, preamble, alignment, group, NR, search, space, resource, network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <thead> <tr> <th style="width: 10%;">Category*</th> <th style="width: 70%;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width: 20%;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">A</td> <td>NOKIA et al. "3GPP TSG RAN WG1 Meeting 90bis R1-1718303"<br/><i>Remaining details on PRACH procedure</i>, 13 October 2017 (2017-10-13),<br/>sections 1-3</td> <td style="text-align: center;">1-25</td> </tr> <tr> <td style="text-align: center;">A</td> <td>NOKIA et al. "3GPP TSG-RAN WG2 #99bis R2-1710817"<br/><i>SR procedure for NR</i>, 13 October 2017 (2017-10-13),<br/>the whole document</td> <td style="text-align: center;">1-25</td> </tr> <tr> <td style="text-align: center;">A</td> <td>CATT. "3GPP TSG RAN WG1 Meeting 90bis R1-1717833"<br/><i>PDSCH and PUSCH resource allocation</i>, 13 October 2017 (2017-10-13),<br/>the whole document</td> <td style="text-align: center;">1-25</td> </tr> <tr> <td style="text-align: center;">A</td> <td>CN 105430750 A (SHARP CORP.) 23 March 2016 (2016-03-23)<br/>the whole document</td> <td style="text-align: center;">1-25</td> </tr> <tr> <td style="text-align: center;">A</td> <td>WO 2015085273 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 11 June 2015<br/>(2015-06-11)<br/>the whole document</td> <td style="text-align: center;">1-25</td> </tr> </tbody> </table> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                 | Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Relevant to claim No. | A | NOKIA et al. "3GPP TSG RAN WG1 Meeting 90bis R1-1718303"<br><i>Remaining details on PRACH procedure</i> , 13 October 2017 (2017-10-13),<br>sections 1-3 | 1-25 | A | NOKIA et al. "3GPP TSG-RAN WG2 #99bis R2-1710817"<br><i>SR procedure for NR</i> , 13 October 2017 (2017-10-13),<br>the whole document | 1-25 | A | CATT. "3GPP TSG RAN WG1 Meeting 90bis R1-1717833"<br><i>PDSCH and PUSCH resource allocation</i> , 13 October 2017 (2017-10-13),<br>the whole document | 1-25 | A | CN 105430750 A (SHARP CORP.) 23 March 2016 (2016-03-23)<br>the whole document | 1-25 | A | WO 2015085273 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 11 June 2015<br>(2015-06-11)<br>the whole document | 1-25 |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Relevant to claim No.                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | NOKIA et al. "3GPP TSG RAN WG1 Meeting 90bis R1-1718303"<br><i>Remaining details on PRACH procedure</i> , 13 October 2017 (2017-10-13),<br>sections 1-3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1-25                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | NOKIA et al. "3GPP TSG-RAN WG2 #99bis R2-1710817"<br><i>SR procedure for NR</i> , 13 October 2017 (2017-10-13),<br>the whole document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1-25                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | CATT. "3GPP TSG RAN WG1 Meeting 90bis R1-1717833"<br><i>PDSCH and PUSCH resource allocation</i> , 13 October 2017 (2017-10-13),<br>the whole document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1-25                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | CN 105430750 A (SHARP CORP.) 23 March 2016 (2016-03-23)<br>the whole document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1-25                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | WO 2015085273 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 11 June 2015<br>(2015-06-11)<br>the whole document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1-25                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| <table style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> * Special categories of cited documents:<br/> "A" document defining the general state of the art which is not considered to be of particular relevance<br/> "E" earlier application or patent but published on or after the international filing date<br/> "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br/> "O" document referring to an oral disclosure, use, exhibition or other means<br/> "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 50%; vertical-align: top;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<br/> "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone<br/> "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art<br/> "&amp;" document member of the same patent family </td> </tr> </table>                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                 | * Special categories of cited documents:<br>"A" document defining the general state of the art which is not considered to be of particular relevance<br>"E" earlier application or patent but published on or after the international filing date<br>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br>"O" document referring to an oral disclosure, use, exhibition or other means<br>"P" document published prior to the international filing date but later than the priority date claimed | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<br>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone<br>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art<br>"&" document member of the same patent family |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
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| Date of the actual completion of the international search<br><br><div style="text-align: center;"><b>18 July 2018</b></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Date of mailing of the international search report<br><br><div style="text-align: center;"><b>31 July 2018</b></div>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |
| Name and mailing address of the ISA/CN<br><br><b>STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA</b><br><b>6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088</b><br><b>China</b><br><br>Facsimile No. <b>(86-10)62019451</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Authorized officer<br><br><div style="text-align: center;"><b>NIU,Xiaojia</b></div><br><br>Telephone No. <b>86-010-53961761</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                                         |      |   |                                                                                                                                       |      |   |                                                                                                                                                       |      |   |                                                                               |      |   |                                                                                                          |      |

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.

**PCT/CN2017/111143**

| Patent document<br>cited in search report |            |    | Publication date<br>(day/month/year) | Patent family member(s) |            |    | Publication date<br>(day/month/year) |
|-------------------------------------------|------------|----|--------------------------------------|-------------------------|------------|----|--------------------------------------|
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