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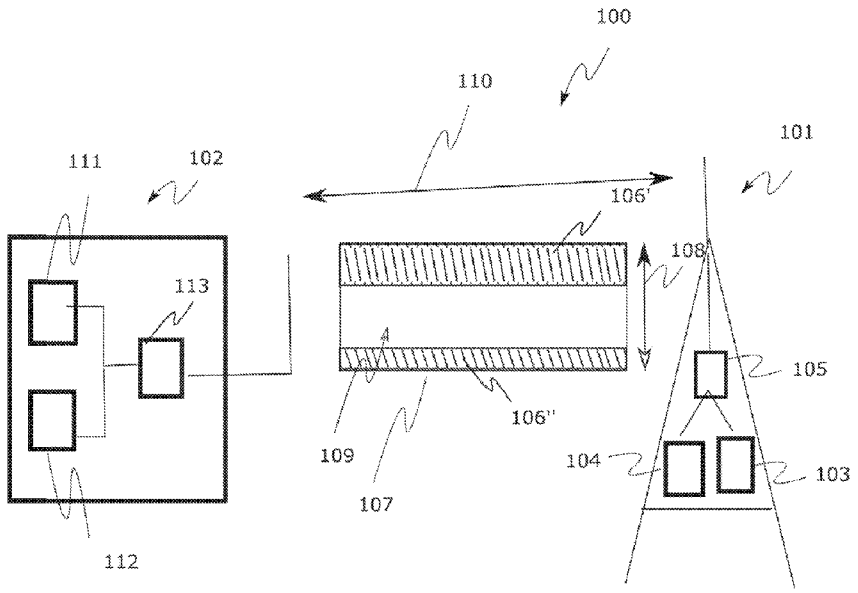

Fig. 1

(57) Abstract: A base station (101) is provided comprising a processing unit (103), wherein the processing unit (103) is adapted to determine a frequency range (106', 106") which is barred for a predeter-mined user equipment and wherein the processing unit (103) is adapted to send the frequency range (106', 106") to the predetermined user equipment (102).

[Continued on next page]

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BASE STATION AND USER EQUIPMENT

FIELD OF INVENTION

The present invention relates to the technical field of communication networks. In particular, the present invention relates to a method for barring one or more frequences for a user equipment.

PRIOR ART

A characteristic of 5G is the ability to support different devices and services with different performance and data traffic models such as IP data traffic, non-IP data traffic, and short data bursts such as for example in Internet of Things based applications. In such applications sensors may send data packages ranging in size from a small status update to streaming video, or modern telephones such as smart phones may generate widely varying amounts of data. In contrast to 4G, the architecture of 5G is not only designed for large amounts of data and thus also supports short data bursts without the need for lengthy signaling procedures before and after sending a small amount of data. Cloud applications like cloud robotics may perform computation in the network rather than in a device and therefore may require low end-to-end latencies and high data rates.

Different devices may also have different mobility requirements. Sensors embedded in infrastructure may be stationary during their entire usable life. Other devices may be stationary during active periods, but nomadic between activations or other devices may by fully mobile.

The document 3GPP TS 22.011 V15.2.0 (2017-09) with the title "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service accessibility (Release 15) relates to access control and describes that under certain circumstances, it will be desirable to prevent UE (user equipment) users from making access attempts - including emergency call attempts - or responding to pages in specified areas of a PLMN.

The document 3GPP TS 36.304 V13.7.0 (2017-09) with the title "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode (Release 13) refers to cell reservations and access restrictions.

The document 3GPP TS 38.213 V1.0.0 (2017-09) with the title "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; Physical layer procedures for control (Release 15)" describes a cell search as a procedure by which a UE acquires time and frequency synchronization with a cell and detects the physical layer Cell ID of that cell.

The document 3GPP TS 38.211 V1.0.0 (2017-09) with the title "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; Physical channels and modulation (Release 15)" defines a carrier bandwidth part as a contiguous subset of the physical resource blocks for a given numerology $_i$ on a given carrier.

Cell reservations and access restrictions may be used in order to prevent connection of certain UEs to certain cells, for example to prevent interferences between the cells.

SHORT DESCRIPTION OF INVENTION

It is an object of the present invention to provide for an efficient access control for a network.

In this text, a base station, a user equipment, a method for barring, a method for blocking an access, a program element and a computer-readable medium are provided.

The subject-matters of the present invention are provided in the independent claims. Features of further exemplary embodiments of the present invention are provided in the dependent claims.

According to an aspect of the present invention a base station (BS) comprising a processing unit is provided. The processing unit is adapted to determine a frequency range which is barred for a predetermined user equipment or which is to be barred for a predetermined user equipment and to send information of this frequency range to the predetermined user equipment, e.g. in the form of a list, a table and/or a database.

According to another aspect of the present invention a user equipment (UE) comprising a processing unit is provided. The processing unit is adapted to receive a frequency range which is barred for the user equipment and to prevent the user equipment from trying of accessing this frequency range. The frequency range may be received from a BS in form of a list. The frequency range may be a single frequency value.

According to another aspect of the present invention a method for barring is provided, comprising determining a frequency range which is barred for a predetermined user equipment and sending an information of the frequency range to the predetermined user equipment. This method may be executed within a BS.

According to yet another aspect of the present invention a method for blocking an access is provided comprising receiving an information of the frequency range and preventing trying of accessing the frequency range. If this method is executed within a UE, a frequency range is received which is barred for this specific UE. The UE then may try preventing of accessing the frequency range.

In New Radio (NR) system, the cell barring mechanism may be different from Long Term Evolution (LTE) due to the reasons as the wider bandwidth in NR system, e.g. 100MHz in low frequency and 400 MHz in high frequency, the multiple SSB in NR system, the SSB contains the Primary Synchronization Signal (PSS)/ Secondary Synchronization Signal (SSS)/Physical Broadcast Channel (PBCH) and Remaining Minimum System Information (RMSI) or Remaining Minimum SI and because there is no bandwidth information in the Master Information Block (MIB) as LTE did.

If the cell barred indication is present in MIB or RMSI, it will only indicate that the current frequency the UE search is barred, but the UE does not know how wide the bandwidth is barred.

In other words, NR supports scalable sub-carrier spacing (SCS) and much wider channel BW (CBW) compared to LTE and NR supports scalable sub-carrier spacing (SCS) compared to LTE's single 15 kHz SCS option. The scalable SCS is expressed as $f_c = 15 \cdot 2^n$ [kHz], where n is a non-negative integer. In an example 15/30/60 kHz SCS values are used in frequency range 1 (FR1) with up to 100 MHz CBW, where FR1 denotes the frequency range of 450 – 6000 MHz or sub-6 GHz bands. 60/120 kHz SCS values are used in frequency range 2 (FR2) with up to 400 MHz CBW, where FR2 denotes the frequency range of 24.25 – 52.6 GHz or mmWave bands.

These different SCS allow for different types of NR numerologies which provide different radio frame structures with different bandwidth.

NR would operate in very wideband and there wouldn't be any issues for the network e.g. a BS or gNB and high-end UEs to handle the full operating band, but not every type of UE may able to work with this kind of wideband. So, the concept of bandwidth part (BWP) may allow a low-end UE, which may not need the full wideband system bandwidth, to be operated in wideband system of NR even if not the complete bandwidth is used. In this concept only a sub range of the complete system bandwidth is provided.

In a LTE system with its single 15 kHz SCS option barring means that the whole system using 20MHz will be barred which is the maximum bandwidth of LTE system. However, in NR system, since the system uses broader bandwidth, it's possible that only part of the system bandwidth is barred. Barring only a sub-frequency range of the complete system bandwidth may make the barring function more flexible, because even if a certain frequency range of the system bandwidth is barred for a UE, within the same band another frequency range may be used by this UE. Therefore, not the complete system bandwidth is barred.

A BS such as a gNB may periodically send synchronization signals PSS/SSS and broadcast channels PBCH

For initial access, an SS Block (SSB / Synchronization Signal Block) is defined. A 4-symbol SSB comprises a 1-symbol PSS, a 1-symbol SSS, and a 2-symbol PBCH, and a bit extra. Upon power on of the UE, the UE finds a good beam of a cell during synchronization and decodes MIB which is sent over PBCH. MIB or RMSI may comprise cell barred indication for that cell found during the cell search of the UE and the UE does not try to connect to this cell. This may only be the case for the current cell associated with the current SSB.

By not connecting to this particular cell the UE cannot use the complete system bandwidth of this cell which can be a very wide frequency range. However, it may be desired that not the complete bandwidth of this call is barred but only a certain frequency range or sub range of the bandwidth provided by the cell. Thus, the processing unit of the BS may be adapted to determine a frequency range and/or a frequency subrange of a system bandwidth and/or a frequency subrange of a cell bandwidth which range is barred for a predetermined user equipment.

Thus, one wideband carrier may be partitioned using multiple SSB.

A processing unit in a UE may also be adapted to ignore a cell barred indication which the UE receives within a MIB and which would instruct the UE to barre the complete cell. The processing unit instead of using the barred indication in MIB is adapted to detect a frequency range within a combination of PBCH and RMSI (PBCH/RMSI) and use this frequency range and/or frequency subrange to access only a portion of a frequency range of a cell, i.e. the frequency range which is not barred. Thus, sending a frequency range and/or frequency subrange from the BS to the UE may allow for barring only a portion of a cell bandwidth.

According to another aspect of the present invention a program element is provided, which, when being executed by a processing unit is adapted to carry out one of the inventive methods.

According to another aspect of the present invention a computer-readable medium comprising program code is provided, which, when being executed by a processing unit is adapted to carry out one of the inventive methods.

A computer-readable medium may be a floppy disk, a hard disk, an USB (Universal Serial Bus) storage device, a RAM (Random Access Memory), a ROM (read only memory) or an EPROM (Erasable Programmable Read Only Memory). A computer readable medium may also be a data communication network, e.g. the Internet, which may allow downloading a program code.

According to another aspect of the present invention the frequency range is provided as a list of frequencies, wherein each frequency of the list of frequencies is a frequency which is barred for the predetermined user equipment.

In an example the PBCH/RMSI comprises the frequency list, which is barred for the UE. The first system information received by a UE is the MIB, which is transmitted in the PBCH channel. The next relevant system information (SI) is RMSI, also called SIB1 (System Information Block Type 1), which will be transmitted in PDSCH (Physical Data Shared Channel) channel. For each frequency in the frequency list exists an associated SSB. The frequency list comprises individual frequency values.

A single frequency value may also be seen as a frequency range. In another example, the frequency list is a list of specific frequency values and/or bandwidth values. The values of the list describe areas or ranges in the frequency domain which cannot be used by this particular UE. These values are blocked for the UE and the UE does not try to use these frequencies for communicating with a network and/or BS. In another example the values can depend on a time such that different bandwidth parts and/or frequency values can be allocated to UE from time to time and can be barred during the other time.

According to another aspect of the present invention each frequency of the list of frequencies further comprises a list of physical cell identities (PCI), wherein the list of physical cell identities indicates that the physical cell identity and the frequency is barred for the predetermined user equipment.

In an example the PBCH/RMSI also comprises a PCI list per frequency in the frequency list. The PCI list indicates that the PCI and frequency is barred for the UE. In other words, A PCI is an indication of a cell on a physical level. By way of a PCI, a detected cell may be identified by a UE. Each frequency may have multiple PCIs which owned by different cells. The PCI list may be a sequence of physical cell IDs and provide a relationship between barring, frequency and PCI list.

By barring a frequency may substantially all the cells using this frequency be barred irrespective of the PCI. However, if the PCI is specified, then substantially only the cell in this frequency and having this PCI will be barred. Consequently, not the complete frequency may be barred but only the frequency when it is used by certain cells. Other cells using this frequency at the same time and not being barred may still use this frequency. Thus, a more flexible barring of frequencies be achieved.

According to another aspect of the present invention each frequency and/or frequency value of the list of frequencies further comprises a bandwidth which is barred for the predetermined user equipment.

The bandwidth may be a range around a certain frequency. By providing a bandwidth a frequency range is indicated however, the exact position of this frequency range is not defined. Each frequency value may be used as an offset in order to specify the exact position of the frequency

range. In an example, the range may be indicated by the list of individual frequencies forming that range.

According to another aspect of the present invention the frequency range is provided as a frequency and a frequency offset list, wherein the frequency derived from the frequency and the frequency offset list is barred for the predetermined user equipment.

In this example the frequency offset list is a list of frequency values which define the frequency range to be barred starting from the frequency as the basis value. In a further example the PBCH/RMSI comprises the frequency and a frequency offset list, the frequency derived from the frequency and a frequency offset list is barred for the UE. For example, there is a frequency which is used as a baseline and another frequency will be specified by the baseline and one offset.

According to another aspect of the present invention each frequency and/or each frequency offset of the frequency offset list further comprises a list of physical cell identities, wherein the list of physical cell identities indicates that the physical cell identity and the frequency and/or the frequency offset is/are barred for the predetermined user equipment. Using the PCI list may allow for blocking frequencies only when they are used by certain cells. Thus, the pci list may reduce the scope of the barred cell and allows for a more flexible baring of frequencies.

For example, the PBCH/RMSI also contains a PCI list per frequency or frequency offset in the frequency list. In other words, in an example a sequence of tuples of two values form the list. The PCI list indicates that the PCI and frequency derived from the frequency and a frequency offset list is barred for the UE. In a further example the PBCH/RMSI also contains the bandwidth corresponding to each frequency. In other words, the frequency may be used as the basis for a bandwidth around that frequency.

According to an aspect of the present invention the processing unit is adapted to send information of the frequency range to the predetermined user equipment via a combination of a Physical Broadcast Channel and a Remaining System Information. Such a combination may be denoted as PBCH/RMSI. This PBCH/RMSI establishes a communication channel between BS and UE for exchanging barring information. By using PBCH/RMSI barring information provided in the MBI can be ignored.

According to an aspect of the present invention the frequency range is a sub range of an aggregated bandwidth and/or the frequency range is a carrier bandwidth part.

By only barring a sub range of a cell bandwidth, system bandwidth, channel bandwidth and/or a carrier bandwidth other frequency ranges of the cell may be used for the UE. In NR each cell may supply an area with a wide frequency range. By barring the complete cell for a certain UE may make the complete frequency range unusable. Barring only sub ranges of the cell bandwidth, system bandwidth and/or a carrier bandwidth may allow for flexible use of the wide bandwidth of a cell. Thus, bandwidth adaptation may be possible.

According to an aspect of the present invention the processing unit is adapted to send the frequency range to a certain group of predetermined user equipment.

In this way, only predefined UE types may be barred from accessing a certain frequency range.

According to another aspect of the present invention the processing unit is adapted to send the frequency range to the predetermined user equipment as a digital signal sequence.

Sending the frequency range or the list of frequency values as a digital signal may allow using a channel which is established between UE and BS such as the PBCH and/or the PBCH/RMSI.

According to an aspect of the present invention the barring for potential frequency and/or potential frequencies or cell and/or cells may be based on a probability and/or the barring timer could be T1 and those two parameters, e.g. probability and value for the timer, are provided by the BS. For the first parameter, the UE may access the barred frequecy and/or the barred frequencies and/or the cell and/or cells based on the probability. For the second parameter, if the UE finds out that it is barred, it may try to access the same frequecy(ies) or cell(s) after T1 expired. In other words, after the UE detects that it can't access certain frequencies and/or cells the UE wait for a set timer T1 to be expired and then may try again to access the barred frequecy and/or the barred frequencies and/or the cell and/or cells.

It has to be noted that aspects of the invention have been described with reference to different subject-matters. In particular, some aspects have been described with reference to apparatus type claims whereas other aspects have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination between features belonging to one type of subject-matter also any combination between features relating to different types of subject-matters is considered to be disclosed with this text. In particular, combinations between features relating to the apparatus type claims and features relating to the method type claims are considered to be disclosed.

SHORT DESCRIPTION OF DRAWINGS

Further embodiments of the invention are described in the following description of the Figures. The invention will be explained in the following in detail by means of embodiments and with reference to the drawing in which is shown:

Fig. 1 shows a communication system comprising a base station and a user equipment according to an exemplary embodiment of the present invention.

Fig. 2 shows a communication channel in a time domain and frequency domain representation according to an exemplary embodiment of the present invention.

Fig. 3 shows the structure of an SSB according to an exemplary embodiment of the present invention.

Fig. 4 shows a bandwidth allocation to different UEs of a carrier according to an exemplary embodiment of the present invention.

Fig. 5 shows a time-frequency diagram with BWPs according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION

In the following the same reference numerals will be used for parts having the same or equivalent function. Any statements made having regard to the direction of a component are made relative to the position shown in the drawing and can naturally vary in the actual position of application.

Fig. 1 shows a communication system 100 comprising a base station (BS) 101 and a user equipment (UE) 102 according to an exemplary embodiment of the present invention.

The BS 101 comprises a first processing unit 103, a second processing unit 104 and a transceiver 105. The first processing unit is adapted to determine a frequency range 106', 106'' which is barred for a predetermined user equipment 102. The barred frequency range 106', 106'' cannot be used by UE 102 when using a communication channel 107 which is allocated by the second processing unit 104 and is used for a communication between UE 102 and BS 101. The BS generates a cell with the communication channel 107 having a cell bandwidth 108, carrier bandwidth 108 and/or system bandwidth 108. The system bandwidth 108 may be an aggregated bandwidth and/or a bandwidth part and may have frame structure built from sub-carrier spacings (SCS). The system may use a very wide bandwidth.

The UE 102 however, may only be adapted to use a portion 109 of the system bandwidth 108 or channel BW 108. In some situation, the UE 102 even doesn't try to connect to barred frequency ranges 106', 106'' when the UE does a cell search and prevent examining the barred frequencies.

Which portion 106', 106'' and/or which frequency range 106', 106'' is barred for the UE 102 and thus cannot be used by the UE 102 is communicated from the BS 101 to the UE 102 via PBCH 110, in particular via PBCH/RMSI 110.

In New Radio (NR) system, the cell barring mechanism may be different from Long Term Evolution (LTE) due to the reasons as the wider bandwidth in NR system, e.g. 100MHz in low frequency and 400 MHz in high frequency, the multiple SSB in NR system, the SSB contains the Primary Synchronization Signal (PSS)/ Secondary Synchronization Signal (SSS)/Physical Broadcast Channel (PBCH) and Remaining Minimum System Information (RMSI) or Remaining Minimum SI and because there is no bandwidth information in the Master Information Block (MIB) as LTE did.

Fig. 3 shows the structure of an SSB 300 according to an exemplary embodiment of the present invention. The SSB 300 comprises PSS 301, SSS 302 and PBCH 303a, 303b, 303c, 303d. These functional blocks are arranged in a frame structure. PSS 301 is arranged at OFDM (Orthogonal Frequency-Division Multiplexing) symbol number 0 and ranges from subcarrier number 56 to 182. SSS 302 is arranged at OFDM symbol number 2 and ranges from subcarrier number 56 to 182. PBCH comprises four PBCH sub-block 303a, 303b, 303c, 303d. The first sub-block 303a is arranged at OFDM symbol number 1 and ranges from subcarrier number 0 to 239, the second sub-block 303b is arranged at OFDM symbol number 2 and ranges from subcarrier number 0 to 47, the third sub-block 303c is arranged at OFDM symbol number 2 and ranges from subcarrier number 192 to 239, the fourth sub-block 303d is arranged at OFDM symbol number 3 and ranges from subcarrier number 0 to 239.

The Remaining Minimum SI (RMSI) is the minimum SI for one UE which can be served in a cell and thus can get service in this cell. The RMSI is provided by the BS and/or cell to the UE. This minimum SI may be SIB1 in NR. In contrast to NR in LTE, the bandwidth information is

transmitted in the SIB1, e.g 20MHz for one cell in DL (Down Link), i.e. in the direction from BS 101 to UE 102.

Multiple SSBs 300 may be transmitted within the frequency span of a carrier used by the serving cell. However, from the UE 102 perspective, each serving cell is associated to at most a single SSB. In other words, for the UE a certain cell is associated with a single SSB.

Fig. 4 shows a bandwidth allocation of a carrier 400 to different UEs 102a, 102b, 102c according to an exemplary embodiment of the present invention. This Fig. 4 shows a scenario with multiple SSBs 300a, 300b, 300c, 300d. In other words, Fig. 4 shows a diagram of UEs associated with certain cells and/or a respective bandwidth. In the example of Fig. 4 four SSBs SSB1 300a, SSB2 300b, SSB3 300c, SSB4 300d are used for the carrier bandwidth. A carrier 400 may be allocated to a plurality of cells which are identified by a NR Cell Global Identifier (NCGI). In Fig. 4 within the carrier 400 two different cells are identified. A first cell 401a may be identified by NCGI = 5 and associated to SSB1 and a second cell 401b may be identified by NCGI = 6, associated to SSB3. Other frequencies may be barred. The cells 401a, 401b may have overlapping Bandwidth Parts (BWPs). In an example a UE 102 is configured to perform RRM (Radio Resource Management) measurements on each of the available SSBs, i.e. SSB1, SSB2, SSB3 and SSB4 in order to find a cell to be attached to. In Fig. 4 three UEs 102a, 102b, 102c are shown. Two UEs 102a, 102b are connected to the same cell having NCGI = 5 as indicated by the initial BWP 402a, 402b. UE 102c is connected to another cell having NCGI=6 as indicated by the initial BWP 402c. In addition, UEs 102a, 102b, 102c have dedicated BWPs which allow to scale the bandwidth. The initial BWP 402a and initial BWP 402b are associated with SSB1, NCGI=5 and the initial BWP 402c is associated with SSB3, NCGI=6. Additional bandwidth can be allocated as dedicated BWP1 and dedicatd BWP2. Thus, every UE 102a, 102b, 102c can have different allocated bandwidth and does not have to use the full system bandwidth.

In order to ensure that the user equipment 102 does not use the barred frequency range 106', 106'' for a communication the UE 102 comprises a processing unit 111, communication device 112 and a transceiver 113. The transceiver 113 is adapted to receive an information of the frequency range which is barred for the user equipment via PBCH 110. In particular the UE 102 receives an information about the barred frequency range, e.g. in form of a list of frequencies. And the processing unit 111 is adapted to prevent the UE 102 from trying of accessing the barred frequency range 106', 106''. In other words, the processing unit 111 ensures that the UE only uses the usable portion 109 of the system bandwidth when the UE establishes a communication channel 107 with the BS 101. Therefore, the communication device 112 of the UE only uses the usable portion 109 of the communication channel 107 when information is exchanged between UE 102 and BS 101 via UE transceiver 113. The processing unit 111 and communication device 112 can be implemented by different processors, or the processing unit 111 and communication device 112 can be integrated into one processor.

The communication channel may be provided as a frame structure comprising Resource Elements and/or Resource Blocks.

Fig. 5 shows a time-frequency diagram 500 with different bandwidth parts (BWP) according to an exemplary embodiment of the present invention. This concept is used to partition a system bandwidth 108 into different parts of bandwidth BWP1 501a, 501b, BWP2 502a, 502b, BWP3 503.

With Bandwidth Adaptation (BA), the receive and transmit bandwidth of a UE 102 does no need to be as large as the bandwidth of the complete cell and can be adjusted. The BS 101 can instruct

a UE to change the bandwidth. In an example during a period of low activity the bandwidth can be reduced to save power. The location of the allocated BWPs 501a, 501b, 502a, 502b, 503 can be moved in the frequency domain, e.g. to increase scheduling flexibility. Also, the subcarrier spacing can be adjusted, e.g. to enable different services. A subset of the total cell bandwidth of a cell is referred to as a Bandwidth Part (BWP) BWP1, BWP2, BWP3 and BA is achieved by configuring the UE 102 with BWP(s) and informing the UE 102 which of the configured BWPs is currently the active one. Other parts of the time-frequency-domain 500 may be barred in order to prevent using them. In Fig. 5 three different BWPs BWP1, BWP2, BWP3 are configured. BWP 1 uses a bandwidth of 40 MHz and subcarrier spacing of 15 kHz and is distributed into two parts 501a, 501b spread along the time axis 504. BWP2 uses a bandwidth of 10 MHz and subcarrier spacing of 15 kHz and is distributed into two parts 502a, 502b spread along the time axis 504. BWP3 uses a bandwidth of 20 MHz and subcarrier spacing of 60 kHz and is one contiguous time range along the time axis 504. The different bandwidth is indicated by different breadth of the blocks along the frequency axis 505. In an example the bandwidth is arranged around the SCS along the frequency axis.

In order to inform the UE 102 about the barred frequency range 106', 106'' different options may be chosen. The RMSI and/or a SIB comprises the cell barred information which is a frequency list, or frequency list and PCI list, or frequency and frequency offset list, or frequency, frequency offset list, and PCI list.

In one example, the RMSI which is sent to the UE 102 via PBCH 110 may comprises a list of barred frequencies. Such a frequency list may comprise frequency values which cannot be used by the UE such as f1 = 100 MHZ, f2 = 101MHz, …., fn = 150 MHz in order to barre the frequency range 106', 106'' from 100MHz to 150 MHz. The frequency list in an example may only comprise individual frequency values but no range values.

In another example the barred frequency range 106', 106'' is provided as a PCI list per frequency in the frequency list. For example, the BS 101 has the PCI 10035. Then the information transferred from BS 101 to UE has the form of frequency followed by PCI values which indicate that the frequency and all the PCIs can not be used by a UE.

The structure of such a list may be:

Frequency 100MHz,
PCI 23,
PCI 45
Frequency 200MHz
PCI 46,
PCI 49
;;;;;;

For a UE receiving this list, the frequency 100MHz may be usable if it is provided from a cell having a PCI different from 23 or 45.

In another example the barred frequency range 106', 106'' is provided as a list which also comprises the bandwidth corresponding to each frequency. In order to refer to the frequency range from 100MHz to 150 MHz as barred for UE 102, such a list may only comprise two values, i.e. f1 = 100, BW1 = 50.

In another example the barred frequency range 106', 106'' is provided as a list which includes the frequency and a frequency offset list.

This list may also additionally comprise a PCI list per frequency and/or a bandwidth

The general structure of a list which can be used to send the frequency range to the UE 102 may have the following format written as an information element:

Partial Bandwidth Barring {
    Frequency
    Bandwidth   <optional>
    PCI List   <optional>
    barred or not barred }

In this list values indicated as <optional> can optionally be added. The value "barred" may indicate that the corresponding frequency is barred for that UE. The value "not barred" may indicate that the corresponding frequency is not barred for that UE 102 and can be used by UE 102.

The offset value in the frequency list is an offset to the frequency signaled by network, wherein the network can decide the offset and calculation based on the implementation.

The frequency list can be transmitted as a standard RMSI message in the PBCH e.g. as shown in Fig. 3.

Fig. 2 shows a communication channel 107 in a time domain and frequency domain representation according to an exemplary embodiment of the present invention. The time domain is indicated by arrow 201. The frequency domain is indicated by arrow 202. Blocks 206', 206'', 206''', 206''', 206''''' indicate barred frequency ranges in the time and frequency domain.

It should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality. Also, elements described in association with different embodiments may be combined.

It should also be noted that reference signs in the claims shall not be construed as limiting the scope of the claims.

LIST OF REFERENCE NUMERALS

100	Communication System
101	Base Station
102	User Equipment
102a	UE1
102b	UE2
102c	UE3
103	first processing unit
104	Second processing unit
105	Transceiver
106', 106''	Barred Frequency Range
107	Communication Channel
108	System Bandwidth
109	usable portion of system bandwidth
110	PBCH
111	Processing unit
112	Communication Device
113	UE Transceiver
201	Time Domain
202	Frequency Domain
206', 206'', 206''', 206''', 206'''''	barred frequencies in time and frequency domain
300	SSB
300a	SSB1 of multiple SSB
300b	SSB2 of multiple SSB

300c	SSB3 of multiple SSB
300d	SSB4 of multiple SSB
301	PSS
302	SSS
303a, 303b, 303c, 303d	PBCH
400	Carrier
401a	First Cell
401b	Second Cell
402a, 402b, 402c	initial BWP
500	time-frequency diagram
501a, 501b	BWP1
502a, 502b	BWP2
503	BWP3
504	time axis
505	frequency axis.

CLAIMS

1. Base station (101) comprising:
a processor (103)
wherein the processor (103) is adapted to determine a frequency range (106', 106'') which is barred for a user equipment; and
a transceiver(105) is adapted to send an information of the frequency range (106', 106'') to the user equipment (102).

2. Base station (101) of claim 1, wherein the information of the frequency range (106', 106'') is provided as a list of frequencies, wherein each frequency of the list of frequencies is a frequency which is barred for the user equipment.

3. Base station (101) of claim 2, wherein each frequency of the list of frequencies further comprises a list of physical cell identities, wherein the list of physical cell identities indicates that the physical cell identity and the frequency is barred for the predetermined user equipment.

4. Base station (101) of claim 2 or 3, wherein each frequency of the list of frequencies further comprises a bandwidth which is barred for the user equipment.

5. Base station (101) of one of claims 1 to 4, wherein the information of the frequency range (106', 106'') is provided as a frequency and a frequency offset list, wherein the frequency derived from the frequency and the frequency offset list is barred for the predetermined user equipment.

6. Base station (101) of claim 4, wherein each frequency and/or each frequency offset of the frequency offset list further comprises a list of physical cell identities, wherein the list of physical cell identities indicates that the physical cell identity and the frequency and/or the frequency offset is/are barred for the user equipment (102).

7. Base station (101) of one of claims 1 to 6, wherein the first processing unit is adapted to send the information of the frequency range (106', 106'') to the user equipment (102) via a combination of a Physical Broadcast Channel and a Remaining System Information.

8. Base station (101) of one of claims 1 to 7, wherein the frequency range is a sub range of an aggregated bandwidth (108) and/or wherein the frequency range is a carrier bandwidth part.

9. Base station (101) of one of claims 1 to 8, wherein the transceiver (105) is adapted to send an information of the frequency range (106', 106'') to a certain group of user equipment.

10. Base station (101) of one of claims 1 to 9, wherein the tansceiver (105) is adapted to send the frequency range (106', 106'') to the user equipment (102) as a digital signal sequence.

11. User equipment (102), comprising:
a processing unit (111) and a transceiver (113);
wherein the transceiver (113) is adapted to receive an information of a frequency range (106', 106'') which is barred for the user equipment (102); and
wherein the processing unit (111) is adapted to prevent the user equipment (102)

from trying of accessing the frequency range.

12. The user equipment (102) of claim 11, wherein the information of the frequency range (106', 106'') is provided as a list of frequencies, wherein each frequency of the list of frequencies is a frequency which is barred for the user equipment.

13. The user equipment (102) of claim 12, wherein each frequency of the list of frequencies further comprises a list of physical cell identities, wherein the list of physical cell identities indicates that the physical cell identity and the frequency is barred for the predetermined user equipment.

14. The user equipment (102) of one of claims 11 to 13, wherein each frequency of the list of frequencies further comprises a bandwidth which is barred for the user equipment.

15. The user equipment (102) of one of claims 11 to 14, further comprising:
a communication device (112);
the communication device being connected to the transceiver (113) and/or to the processing unit (111).

16. The user equipment (102) of one of claims 11 to 15, wherein the user equipment is adapted to receive the frequency range (106', 106'') as a digital signal sequence.

17. A method for barring, comprising:
determining a frequency range which is barred for a user equipment;
sending an information of the frequency range to the user equipment.

18. A method for blocking an access, comprising:
receiving an information of a frequency range which is barred;
preventing trying of accessing the frequency range.

19. A program element, which when being executed by a processing unit is adapted to carry out the method of claim 17 and/or the method of claim 18.

20. A computer-readable medium comprising program code, which when being executed by a processing unit is adapted to carry out the method of claim 17 and/or the method of claim 18.

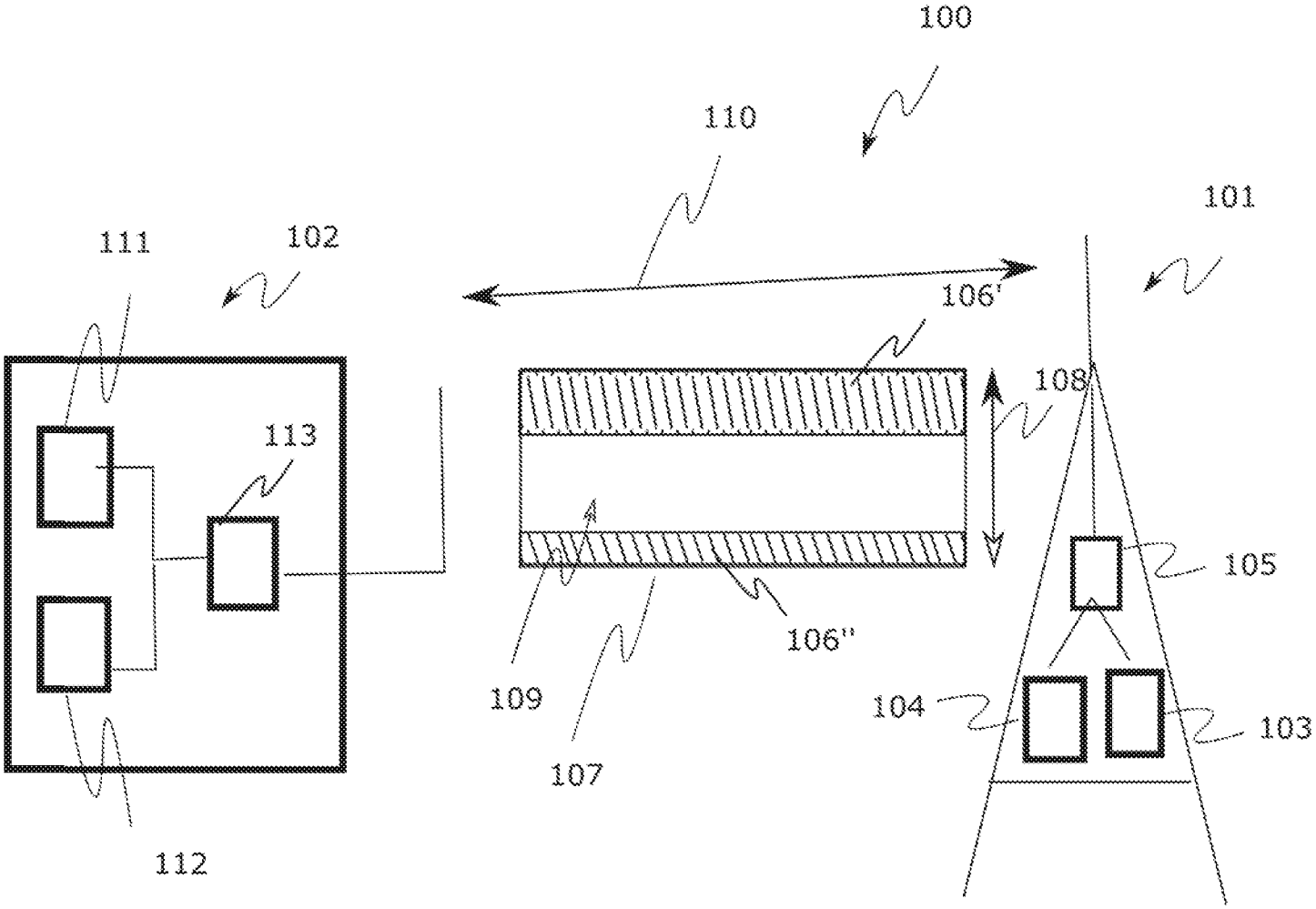
100
110
101
111
102
106'
108
113
105
106''
109
104
103
107
112

Fig. 1

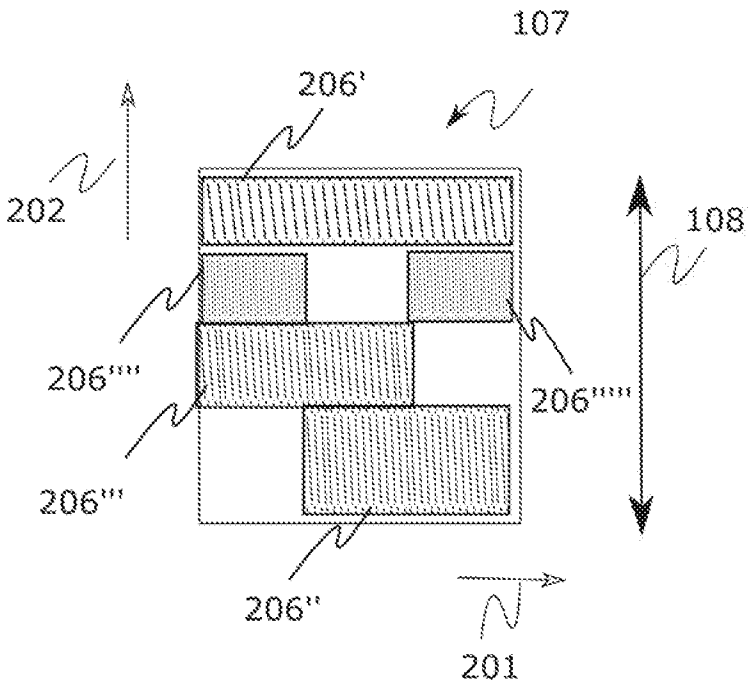
107
206'
202
108
206''''
206'''''
206'''
206''
201

Fig. 2

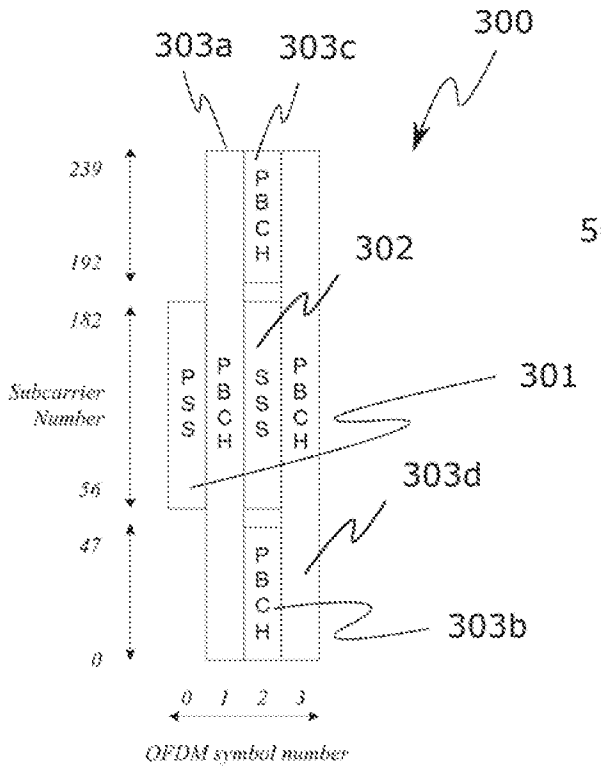

Fig. 3

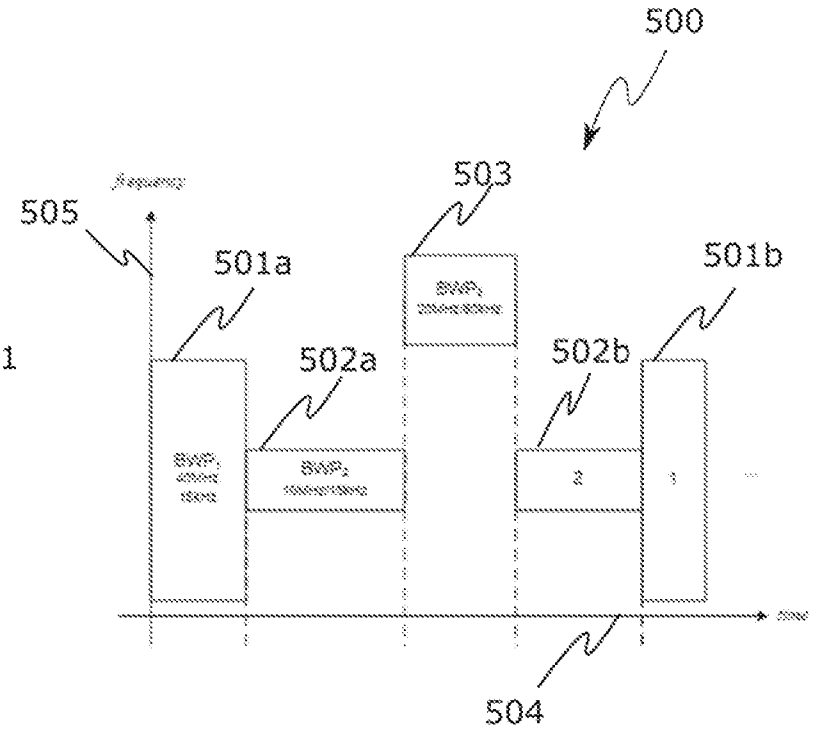

Fig. 5

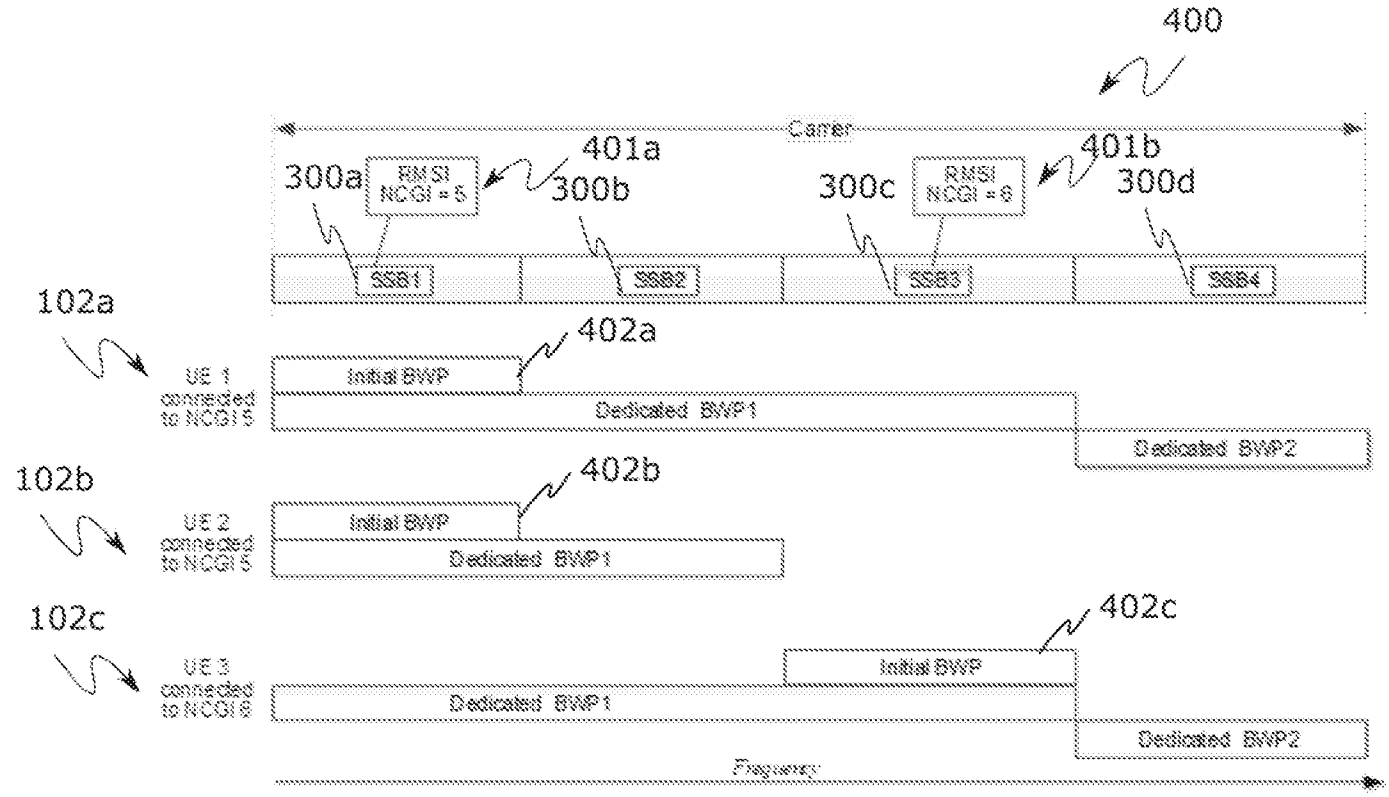

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/117539

A. CLASSIFICATION OF SUBJECT MATTER

H04L 29/02(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,CNKI,WPI,EPODOC,3GPP: UE, frequency, range, barred, prevent, prohibit, forbid, list, ID, band, offset

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1739991 A1 (RESEARCH IN MOTION LIMITED) 03 January 2007 (2007-01-03) description paragraphs [0021]-[0056], claims 1-19, figures 1-13	1-20
A	CN 102577525 A (APPLE INC.) 11 July 2012 (2012-07-11) the whole document	1-20
A	CN 101553002 A (HUAWEI TECHNOLOGY CO., LTD.) 07 October 2009 (2009-10-07) the whole document	1-20
A	US 2015264687 A1 (SPRINT SPECTRUM L.P.) 17 September 2015 (2015-09-17) the whole document	1-20
A	WO 2014065580 A1 (LG ELECTRONICS INC.) 01 May 2014 (2014-05-01) the whole document	1-20

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 January 2019	**26 February 2019**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/117539

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				AU	2006202765	A1	18 January 2007
				SG	149026	A1	29 January 2009
				KR	20070003714	A	05 January 2007
				TW	200715884	A	16 April 2007
				EP	1775975	A1	18 April 2007
				MX	PA06007638	A	09 May 2007
				CA	2551241	A1	01 January 2007
				CN	1901751	A	24 January 2007
				SG	128660	A1	30 January 2007
				IN	200601539	I1	15 June 2007
CN	102577525	A	11 July 2012	US	2011075589	A1	31 March 2011
				TW	201132171	A	16 September 2011
				JP	2013507049	A	28 February 2013
				KR	20120093236	A	22 August 2012
				GB	2474111	A	06 April 2011
				EP	2484155	A1	08 August 2012
				WO	2011041171	A1	07 April 2011
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				BR	PI0910339	A2	06 October 2015
				IN	201003197	P2	19 November 2010
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WO	2014065580	A1	01 May 2014	US	2015237668	A1	20 August 2015