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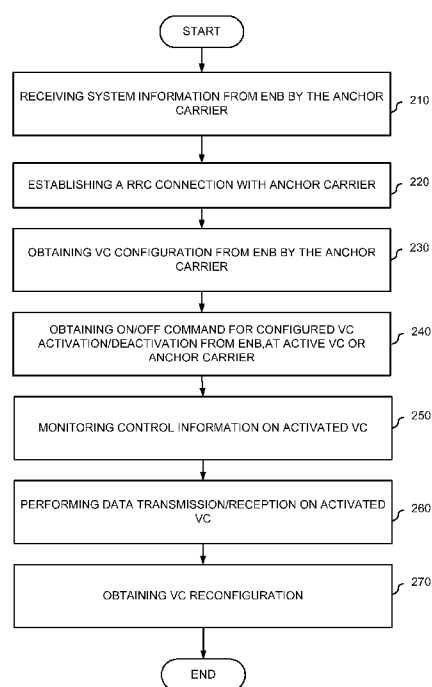


FIG. 2

(57) **Abstract:** Methods and apparatus are provided for virtual carrier operation, in one novel aspect, a method is provided, comprising: receiving system information from eNB by UE in a wireless system; establishing a RRC connection with the eNB; obtaining a VC configuration from the eNB; and performing data transmission or reception on aggregated VC BW based on the VC configuration. In another novel aspect, the VC configuration comprises: offset direction, offset value, and VC BW value. In another novel aspect, the basic step of offset value is 5PRBs, the offset value is one or more basic step, the VC BW value is one or more times of the basic step. And UE receives VC ON/OFF command from the eNB to determine the activated VCs. Multiple VC are aggregated by the UE, the aggregating pattern is indicated by the eNB, or determined by the UE.

METHODS AND APPARATUS FOR VIRTUAL CARRIER OPERATION

TECHNICAL FIELD

[0001] The disclosed embodiments relate generally to wireless communication, and,
5 more particularly, to Methods and apparatus for virtual carrier operation.

BACKGROUND

[0002] Research / trial work has started in ITU, 3GPP, and other institutes /
specification organizations / research groups on a global scale, to develop
10 requirements and specifications for new radio systems, as in the Recommendation in
ITU-R M.2083 “Framework and overall objectives of the future development of IMT
for 2020 and beyond”. Compared to IMT-A system, ITU-R specifies that NR system
is capable to provide 20Gbps peak data rate, 100Mbps user experienced data rate, and
1ms latency. To achieve these KPIs, larger bandwidth than those of earlier generation
15 technologies (e.g., 3G in 5MHz, 4G in 20MHz), is one possible solution for delivery
of important new capabilities. Taking LTE system as an example, the supported
maximal bandwidth is 20MHz. Due to the bandwidth limitation, carrier aggregation is
proposed and deployed to improve data rate. Therefore, the NR system should be able
to use any spectrum band ranging at least up to 100GHz that may be made available for
20 wireless communications even in a more distant future. As well known, larger
bandwidth will require a larger FFT size calculation for an OFDM based system,
which will result in larger power consumption. Then, this invention proposes a narrow
band operation under a larger carrier bandwidth for NR system design. To
differentiate eMTC and NB-IoT, such narrow band is named as a narrow virtual
25 carrier (VC), i.e., a wider system bandwidth comprises multiple narrower virtual
carriers, and virtual carrier is UE-specific.

SUMMARY

[0003] Methods and apparatus are provided for virtual carrier operation.

[0004] In one novel aspect, a method comprises: receiving system information from eNB by UE in a wireless system; establishing a RRC connection with the eNB;
5 obtaining a VC configuration from the eNB; and performing control information transmission or reception on a VC BW based on the VC configuration. In another novel aspect, the VC configuration comprises: offset direction, offset value, and VC BW value. In another novel aspect, the basic step of offset value is 5PRBs, the offset value is one or more basic step, the VC BW value is one or more times of the basic
10 step. And UE receives VC ON/OFF command from the eNB to determine the activated VC. Multiple VC BS are aggregated by the UE, the aggregating pattern is indicated by the eNB, or determined by the UE.

[0005] Further details and embodiments and methods are described in the detailed description below. This summary does not purport to define the invention. The
15 invention is defined by the claims.

BRIEF DESCRIPTION OF DRAWINGS

[0006] The accompanying drawings, where like numerals indicate like components, illustrate embodiments of the invention.

20 [0007] FIG. 1 illustrates an exemplary wireless network 100 with LTE RACH procedure enhancement in accordance with embodiments of the current invention.

[0008] FIG. 2 illustrates flow chart of UE in virtual carrier operation according to the embodiments of this invention.

[0009] FIG.3A and FIG.3B illustrate the VC BW allocation under the same or
25 different basic offset size according to the embodiments of this invention.

[00010] FIG.4A and FIG.4B illustrate the VC allocation according to the embodiments of this invention.

[00011] FIG.5A and FIG.5B illustrate the VC aggregation pattern according to the embodiments of this invention.

30 [00012] FIG.6A and FIG.6B illustrate the timing of VC ON/OFF command

according to the embodiments of this invention.

DETAILED DESCRIPTION

[00013] Certain terms are used throughout the description and following claims to refer to particular components. As one skilled in the art will appreciate, manufacturers may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not function. In the following description and in the claims, the terms "include" and "comprise" are used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to ...".

Also, the term "couple" is intended to mean either an indirect or direct electrical connection. Accordingly, if one device is coupled to another device, that connection may be through a direct electrical connection, or through an indirect electrical connection via other devices and connections. The making and using of the embodiments of the disclosure are discussed in detail below. It should be appreciated, however, that the embodiments can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative, and do not limit the scope of the disclosure. Some variations of the embodiments are described. Throughout the various views and illustrative embodiments, like reference numbers are used to designate like elements. Reference will now be made in detail to some embodiments of the invention, examples of which are illustrated in the accompanying drawings.

[00014] FIG.1 illustrates a mobile communication network 100 with UEs / mobile stations in accordance with embodiments of the current invention. Wireless communication system 100 includes one or more fixed base infrastructure units forming a network distributed over a geographical region. The base unit may also be referred to as an access point, an access terminal, a base station, a Node-B, an eNode-B (eNB), or by other terminology used in the art. In FIG. 1, the one or more base stations 101 and 102 serve a number of UEs 103 and 104 within a serving area, for example, a cell or a cell sector. The disclosure, however, is not intended to be limited to any particular wireless communication system.

[00015] Generally, serving base stations 101 and 102 transmit downlink communication signals 112 and 113 to UEs or mobile stations in the time and/or frequency domain. UEs or mobile stations 103 and 104 communicate with one or

more base stations 101 and 102 via uplink communication signals 111 and 114. UE or the mobile station may also be referred to as a mobile phone, laptop, and mobile workstation and so on. In FIG. 1, the mobile communication network 100 is an OFDM/OFDMA system comprising a base station eNB 101 eNB 102 and a plurality of UE 103 and UE 104. When there is a downlink packet to be sent from the eNB to the UE, each UE gets a downlink assignment, e.g., a set of radio resources in a physical downlink shared channel (PDSCH). When a UE needs to send a packet to eNB in the uplink, the UE gets a grant from the eNB that assigns a physical uplink shared channel (PUSCH) consisting of a set of uplink radio resources. The UE gets the downlink or uplink scheduling information from a new RAT physical downlink control channel (NR-PDCCH), which is targeted specifically to new RAT UEs / mobile stations and has similar functionalities as legacy PDCCH, EPDCCH and MPDCCH. The downlink or uplink scheduling information and the other control information, carried by NR-PDCCH, is referred to as downlink control information (DCI).

[00016] FIG. 1 also shows an exemplary diagram of protocol stacks for control-plane for UE 103 and eNB 101. UE 103 has a protocol stack 121, which includes the physical (PHY) layer, the medium access control (MAC) layer, the radio link control (RLC) layer, the packet data convergence protocol (PDCP) layer, and the radio resource control (RRC) layer. Similarly, base station eNB 101 has a protocol stack 122, which includes the PHY layer, the MAC layer, the RLC layer, the PDCP layer, and the RRC layer, each of which connects with their corresponding protocol stack of UE protocol stack 121.

System and behaviors

[00017] In one novel aspect of this invention, a unified indication way for VC operation under different system BW & subcarrier spacing is introduced, wherein in the VC configuration, comprising: offset direction + offset value + VC BW. Here, the offset direction is defined relative to the central frequency of anchor carrier, which is a default bandwidth for cell access, the offset value is based on a factor of a basic step, and the VC BW is also based on the basic step. Then, eNB indicates the VC configuration comprising Offset direction + offset value + VC BW to each UE, and the UE determines the location of configured VC, and uses the aggregated VCs for data transmission/reception, if multiple VCs are configured. Note that VC configuration is UE-specific, and multiple VCs can be configured for each UE. Then,

each UE can operate within a set of aggregated UE-specific narrow bandwidth, relative to the large system bandwidth. Considering the design principle of VC operation, it's preferred to configure a set of consecutive resources in one embodiment, since the actual BW will be larger than the logical aggregated BW if the configured VCs are discrete.

[00018] In another novel aspect of this invention, the payload size for a specific VC configuration is unified, based on the proposed unified VC indication way. In a word, the payload size for a specific VC indication does not vary, and is independent to system BW and subcarrier spacing. The main design principle is to have different basic step value under different system bandwidth and subcarrier spacing in one embodiment. I.e., the basic step value is proportional to system BW. The offset value and VC BW is a multiple of the basic step value, respectively.

[00019] Using the above methods and system, flexible VC configuration under various system bandwidth and subcarrier spacing could be allowed. The VC configuration for example is denoted by 5 bits, the basic step for offset granularity: {5, 10, 20, 25, 40, 50} PRB. The basic step for offset granularity and subcarrier spacing should be known to UEs to determine VC location and VC BW. In this case, at most 5 VCs can be configured regardless of system bandwidth, and one VC BW can span over half bandwidth at most.

[00020] In one embodiment, the DL / UL VC configuration are separate. The UL VC BW is restricted considering coverage and limited Tx power. In another embodiment, the DL and UL VC is paired by a specific duplex gap.

[00021] FIG. 1 further shows simplified block diagrams of UE 103 and base station 101 in accordance with the current invention.

[00022] Base station 101 has an antenna array 155 comprising one or more antennas, which transmit and receive radio signals. A RF transceiver module 153, coupled with the antenna, receives RF signals from antenna array 155, converts them to baseband signals and sends them to processor 152. RF transceiver 153 also converts received baseband signals from processor 152, converts them to RF signals, and sends out to antenna array 155. Processor 152 processes the received baseband signals and invokes different functional modules to perform features in base station 101. Memory 151 stores program instructions and data 154 to control the operations of base station 101. Base station 101 also includes a set of control modules, such as VC configuration module 158, to determine the VC configuration for UE, and transmit

the VC configuration to UEs.

[00023] UE 103 has an antenna array 135 with one or multiple antennas, which transmits and receives radio signals. A RF transceiver module 134, coupled with the antenna, receives RF signals from antenna array 135, converts them to baseband signals and sends them to processor 132. RF transceiver 134 also converts received baseband signals from processor 132, converts them to RF signals, and sends out to antenna 135. Processor 132 processes the received baseband signals and invokes different functional modules to perform features in mobile station 101. Memory 131 stores program instructions and data 136 to control the operations of mobile station 101. UE 103 also includes a set of control modules that carry out functional tasks, such as VC configuration module, to determine the VC BW and location, based on VC configuration from eNB, and monitor/transmit signal on the configured VCs.

[00024] In a third novel aspect of this invention, one/multiple higher layer configured VCs can be muted by ON/OFF command. It's up to network decision whether to deactivate some VCs for transmission. The ON/OFF command can be dynamic, compared to VC configuration by higher layer.

[00025] FIG. 2 illustrates flow chart of UE in virtual carrier operation according to the embodiments of this invention. First, UE receives system information from eNB in step 210, the system information comprises: sync information, MIB, SIB, etc. In step 220, UE establishes RRC connection at anchor carrier. In step 230, UE obtains configuration about virtual carrier from eNB within the anchor carrier. Optionally, in step 240, UE obtains on/off command for VC activation from eNB, in one case, the ON/OFF command for VC activation is obtained from the anchor carrier, in another case, the ON/OFF for VC activation/deactivation is obtained from the aggregated VCs. And in step 250, UE monitors the control information transmitted on the aggregated UE-specific VCs (or UE-specific VC), if the eNB indicated the ON/OFF command to UE, then UE monitors the activated VCs for control information, and then performs data transmission/reception on the activated VCs in step 260. If necessary, UE could perform CSI measurement, and report the CSI to eNB, the CSI reporting is used for eNB for VC reconfiguration, and UE receives higher layer reconfiguration in step 270 to update the VC reconfiguration.

[00026] In this embodiment, the default anchor carrier is also named as a common VC or central VC (CVC), which is used for initial cell access, such as NR system information transmission, such as NR-sync, NR-MIB, and/or NR-SIB, and/or RRC

connection setup. For the NR system, information about CVC BW is carried by NR-MIB in one embodiment. To differentiate the anchor carrier or CVC, the configured UE-specific VC is named dedicated VC (DVC).

5 **VC configuration method and payload**

[00027] For different system BW, the information about VC indication comprises: offset direction, offset value, VC BW. If the offset direction is denoted by one bit, bit 0 means one direction from CVC central, and bit 1 means the opposite direction from the central frequency point of CVC. For the offset value field and the VC BW value field, two coefficients are given, and the offset value/VC BW are obtained by multiplying the coefficients with the basic step value. This VC indication format could be used in different system BWs and subcarrier spacing values, so it is called a unified indication way for VC configuration.

[00028] In one embodiment, basic step value can be referenced to Tables 1~4, wherein the basic step value under different system BWs and corresponding VC number is summarized with 15KHz, 60KHz, 240KHz, and 75KHz subcarrier spacing, respectively. In these tables, 12 REs per PRB in LTE system is assumed and PRB number under different system BW scales down / up with different subcarrier spacing, with a restriction as 4096 IFFT/FFT operation.

[00029] In Tables 1~4, one design option (i.e., Option 1) is to set basic step value proportional to system BW to have same maximal VC number under different system BW and subcarrier spacing values. The maximal VC number is 5 in this example. In option 2, the basic step size is derived from legacy RBG size for resource allocation, and different VC number will be obtained under different cases. Further, the obtained maximal VC number under Option 2 is larger than that of Option 1. For example, if the basic step size is 2PRBs for BW=5MHz, the maximum number of VC is 13 in Table 1.

[00030] Considering signaling overhead, Option 1 is more efficient and simple, which results in a unified payload to configure UE-specific VCs with a same maximal VC number under different system BW and subcarrier spacing. Then, in the following embodiments, Option 1 is used as a design assumption, which means that the basic step size is dependent on the system BW and subcarrier spacing. Therefore, up to 5 VC can be configured in different system BWs, and each VC BW is a multiple of the basic step size.

Table 1 Basic step size and VC number under different system BW with 15KHz
subcarrier spacing

System BW (MHz)	FFT size	PRB number	Option 1: VC number / basic step size	Option 2: VC number / basic step size
5	512	25	5 / 5	13 / 2
10	1024	50	5 / 10	17 / 3
20	2048	100	5 / 20	25 / 4
40	4096	200	5 / 40	40 / 5

5

Table 2 Basic step size and VC number under different system BW with 60KHz
subcarrier spacing

System BW (MHz)	FFT size	PRB #	Opt 1: Max VC # / basic step size	Opt 2: Max VC #/ basic step size
20	512	25	5 / 5	13 / 2
40	1024	50	5 / 10	13 / 4
80	2048	100	5 / 20	13 / 8
100	2048	125	5 / 25	13 / 10
160	4096	200	5 / 40	13 / 16
200	4096	250	5 / 50	14 / 18

10 Table 3 Basic step size and VC number under different system BW with 240KHz
subcarrier spacing

System BW (MHz)	FFT size	PRB #	Opt 1: Max VC # / basic step size	Opt 2: Max VC #/ basic step size
80	512	25	5 / 5	13 / 2
160	1024	50	5 / 10	13 / 4
320	2048	100	5 / 20	13 / 8
400	2048	125	5 / 25	13 / 10
800	4096	250	5 / 50	14 / 18

Table 4 Basic step size and VC number under different system BW with 75KHz subcarrier spacing

System BW (MHz)	FFT size	PRB #	Opt 1: Max VC # / basic step size	Opt 2: Max VC # / basic step size
25	512	25	5 / 5	13 / 2
50	1024	50	5 / 10	17 / 3
100	2048	100	5 / 20	25 / 4
200	4096	200	5 / 40	40 / 5

[00031] Please refer to FIG.3A and FIG.3B, FIG.3A and FIG.3B illustrates the VC location under different VC BWs.

[00032] In FIG.3A, the system BW is expressed as 25 PRBs, so the basic step size is 5 PRBs. For the VC BW=1x basic step size =5PRB, from the central to the right direction, there is 3 VCs, 310, 320 and 330. In detail, VC 310 with a BW as 1x basic step, has an offset = 1x basic step to the central. VC 320 with a BW as 2x basic step, has an offset = 1x basic step to the central, while VC 330 with a BW as 3x basic step, has an offset =1x basic step. Here, the central is defined as the central frequency of system BW.

[00033] FIG. 3B illustrates the VC location under the system BW as 50 PRBs and basic step size as 10 PRBs, no further explanation.

[00034] To summarize VC configuration, the VC offset direction field could be **1-bit** indication for two directions; the VC offset field is of several bits to indicate the offset value, which means the gap distance between the central of a configured VC and the central frequency point of system BW, by configuring an coefficient. Then, the offset value is obtained by multiplying the indicated coefficient with the basic step size, which depends on system BW/subcarrier spacing. The payload for this indication is , for example, **2 bits**, because at most there could be 5 VC BW allocated and at most 3 VCs at one direction. For the VC BW, it is various, and extended by one or multiple basic step. Because there is up to 3x step size in one direction, for example the VC BW field could be expressed by **2 bits**, i.e., an coefficient of the basic step size.

[00035] It should be noted that the basic step size should be known to UE when to determine VC location after receiving VC configuration. As described, the basic step size can be derived from a logical system BW by PRB number and subcarrier spacing.

Since system BW may be various in NR system, it's preferred to configure the basic step value by higher layer message, but not to configure system BW.

[00036] FIG.4A and FIG.4B illustrate the VC allocation according to the embodiments of this invention. In FIG.4A, CVC is located at the central of system BW, then, all VC configuration is based on the central frequency point of CVC. VC1 locates at a frequency point which has an offset of 2x basic step relative to the central, and the offset direction is from the central point to the upper side. For VC2, the offset value is 1x basic step, and the offset direction is from the central point to the down side. Here, VC1 BW and VC2 BW is assumed to be 1x basic step. Different from FIG. 4A, CVC is not at the central point of system BW, i.e., there is an additional central offset between the central point of CVC and the central point of system BW, in FIG. 4B. Then, VC1 and VC2 location determination can be obtained by the same way as FIG. 4A, as long as the central offset is indicated to UEs. FIG. 4A and FIG.4B is for illustration, not limitation.

Aggregated BW operation

[00037] The configured multiple VCs will be aggregated to a set of radio resources for data transmission/reception, if multiple VCs are configured to one UE. Multiple VCs are indexed logically according to the configuration, but regardless of frequency domain location, since UE may have no idea of system bandwidth. These VCs are aggregated by a certain pattern. For example, a set of radio resources is obtained by aggregating configured VC1, VC2 and VC3 according to logical index within the configuration, i.e., VC1, VC 2 and VC 2, or according to aggregation index of VC2, VC1, VC3. In the latter way, the eNB should further indicate the aggregating pattern to UE, and the aggregating pattern could be UE-specific in one embodiment. Or a predefined aggregation pattern is applied to all UEs in another embodiment. Here, the predefined aggregation pattern can be a function of VC number, cell ID, UE ID (e.g., C-RNTI), subframe index, etc. One example for predefined aggregation pattern is configured VCs are aggregated by logical index.

[00038] FIG. 5A and FIG. 5B illustrate examples for VC aggregation. In FIG. 5A, VC1 and VC2 are configured to one UE. In this example, resources within VCs are aggregated according to logical VC index and indexed by PRB one by one. In FIG. 5B, VC1, VC2 and VC 3 are configured to one UE, and these VCs are aggregated by the index of VC2, VC3, VC1, according to eNB configuration. Then, the set of UE-

specific logical resources for data transmission/reception is obtained as PRB #0~PRB #N, regardless of system BW.

[00039] Under VC aggregation, logical resources for data transmission / reception is UE-specific. In a word, the aggregated VC BW is UE-specific and various.

- 5 Considering a maximal 5 VC over system BW in one example, Table 5 illustrates the aggregated VC BW under different aggregation levels with different basic step values.

Table 5 Aggregated BW under different aggregation levels

Basic step value	Aggregated BW by different aggregations levels of basic step				
	1x	2x	3x	4x	5x
5	5	10	15	20	25
10	10	20	30	40	50
20	20	40	60	80	100
25	25	50	75	100	125
40	40	80	120	160	200
50	50	100	150	200	250

- 10 It's intuitive that resource allocation (RA) payload carried within DCI to indicate the exact resources for data transmission, varies with BW, which will result in various DCI payload. In one embodiment, a unified RA payload determined by system BW is applied. However, it will reduce spectrum efficiency since UEs may only access a set of UE-specific aggregated BW, smaller than system BW. In another embodiment, RA
- 15 payload varies with aggregated VC BW. Considering VC BW is various, it's proposed that RA payload is categorized into multiple groups by grouping aggregated VC BW. As shown in Table 5, the different aggregated BW could be grouped together according to some criterion. The different aggregated BWs are grouped together according to the range of value, values 5, 10 are defined as group 1, and
- 20 value, 15, 20 are defined as group 2, value 30, 40, 50, 60 and 75 are defined as group 3, values 80, 100 are defined as group 4, values 120, 125 are defined as group 5, values 160, 200 are defined as group 6, and values 250 is defined as group 6. The above grouping is an example, the above groups could be combined or separated based of the different requirement. In this way, RA overhead is restricted into several
- 25 levels.

[00040] To avoid too larger RA overhead, RA granularity should change with

aggregated VC BW. Table 6 illustrates the RA granularity for different aggregated BW. Please refer to Table 6, under RA type 2 or RA type 0 of LTE system, if the range of aggregated BW is within 10-25 PRB, the RA granularity could be set as 2, and the RA overhead is about 9 bits for type 2, and 13 bits for type 0. Using the adaptive RA granularity, the RA overhead could be maintained within a substantially similar range.

Table 6 RA granularity for different aggregated BW

Aggregated BW (PRB #)	RA granularity (PRB #)	RA overhead (Type 2 / Type 0 bit)
≤ 10	1	6 / 10
(10, 25]	2	9 / 13
(25, 75]	3	12 / 25
(75, 100]	4	13 / 25
(100, 150]	6	14 / 25
(150, 200]	8	15 / 25
(200, 250]	10	15 / 25

10 **VC ON/OFF (activation / deactivation)**

[00041] To provide scheduling flexibility and further improve UE power consumption, configured VCs can be deactivated or activated through dynamic VC ON/OFF command, according to the network scheduling. Please refer to step 240 of FIG.2, wherein UEs should monitor VC ON/OFF command to determine the resources for data transmission/reception. Considering processing time and device settling time, the VC ON/OFF command is valid after K subframes from the timing position of receiving VC ON/OFF command.

[00042] In one embodiment, the container for the VC ON/OFF command is a UE-specific compact DCI dedicated for VC activation/deactivation. Such compact DCI is transmitted over a dedicated control channel, which can be CDM based to improve spectrum efficiency in one case.

[00043] In another embodiment, the VC ON/OFF command is carried by a normal UE-specific DCI, wherein a bitmap is used for configured VC activation/deactivation. The bitmap length can be unified as the maximal VC number in one case, or varies according to the number of configured VCs.

[00044] In a third embodiment, the VC ON/OFF command is indicated by a common signaling or DCI, broadcast to multiple UEs. For example, a bitmap with a

unified length is used for each UE, and is carried by DCI format 3/3A, or carried by data channel, which is scheduled by common DCI. In this way, a common RNTI, which is cell-specific or group-specific, should be assigned to UEs. Further, UE index within the signaling is be signaled in one case, or is determined according to a predefined function, which is a function of UE ID, in another case.

VC ON/OFF command Monitoring

[00045] In one embodiment, VC ON/OFF command transmission is cell-specific. In a word, such command is transmitted at cell-specific locations in time domain, no matter such command is UE-specific, group-specific or cell-specific. In another embodiment, VC ON/OFF command can be transmitted at UE-specific time positions, with a certain periodicity. The periodicity can be same or different for UEs.

[00046] Please refer to FIG. 6A and FIG. 6B, FIG. 6A and FIG. 6B illustrate the timing of VC ON/OFF command. In FIG.6A, assuming VC ON/OFF command periodicities for UE #1 and UE#2 are different, VC ON/OFF command for UE #1 is denoted by solid line, and VC ON/OFF command for UE #2 is denoted by dash line.

[00047] In FIG.6B, the periods for different UE are identical, and the time occasions are also identical. For example, VC ON/OFF command for UE #1 is denoted by solid line, and VC ON/OFF command for UE #2 is denoted by dash line. In this figure, the starting points for VC ON/OFF command monitoring are different for UE #1 and UE #2, but they share the same time occasions for VC activation / deactivation monitoring. Though time location is identical the VC ON/OFF command of different UEs can be frequency division multiplexing (FDM), or code division multiplexing (CDM).

[00048] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more. Combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" include any combination of A, B, and/or C, and

may include multiples of A, multiples of B, or multiples of C. Specifically, combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed as a means plus function unless the element is expressly recited using the phrase "means for."

[00049] The techniques described herein may be used for various wireless communication systems such as CDMA, TDMA, FDMA, OFDMA, SC-FDMA and other systems. The terms "system" and "network" are often used interchangeably. A CDMA system may implement a radio technology such as Universal Terrestrial Radio Access (UTRA), cdma2000, etc. UTRA includes Time Division Synchronous Code Division Multiple Access (TD-SCDMA), Wideband-CDMA (W-CDMA) and other variants of CDMA. Further, cdma2000 covers IS-2000, IS-95 and IS-856 standards. A TDMA system may implement a radio technology such as Global System for Mobile Communications (GSM). An OFDMA system may implement a radio technology such as Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM.RTM., etc. UTRA and E-UTRA are part of Universal Mobile Telecommunication System (UMTS). 3GPP Long Term Evolution (LTE) is a release of UMTS that uses E-UTRA, which employs OFDMA on the downlink and SC-FDMA on the uplink. UTRA, E-UTRA, UMTS, TD-SCDMA, LTE and GSM are described in documents from an organization named "3rd Generation Partnership Project" (3GPP). Additionally, cdma2000 and UMB are described in documents from an organization named "3rd Generation Partnership Project 2" (3GPP2). Further, such wireless communication systems may additionally include peer-to-peer (e.g., mobile-to-mobile) ad hoc network systems often using unpaired unlicensed spectrums, 802.xx wireless LAN, BLUETOOTH and any other short- or long-range, wireless communication techniques.

[00050] Although the embodiments and their advantages have been described in

detail, it should be understood that various changes, substitutions, and alterations can be made herein without departing from the spirit and scope of the embodiments as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, 5 manufacture, composition of matter, means, methods, and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed, that perform substantially the same function or achieve substantially the same result as the 10 corresponding embodiments described herein may be utilized according to the disclosure. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps. In addition, each claim constitutes a separate embodiment, and the combination of various claims and embodiments are within the scope of the disclosure.

CLAIMS

1. A method, comprising:
receiving system information from eNB by UE in a wireless system;
5 establishing a RRC connection with the eNB;
obtaining a VC configuration from the eNB; and
performing data transmission or reception on aggregated VC BW based on the VC configuration.
2. The method of claim 1, wherein the VC configuration comprises: offset
10 direction, offset value, and VC BW value.
3. The method of claim 2, wherein the basic step of offset value is 5PRBs, the offset value is one or more basic step.
4. The method of claim 3, wherein the VC BW value is one or more times of the basic step.
- 15 5. The method of claim 1, wherein further comprising: receiving VC ON/OFF command from the eNB to determine the activated VC by the UE.
6. The method of claim 1, wherein further comprising: reporting CSI to eNB to determine whether update the VC configuration for the UE.
7. The method of claim 1, wherein multiple VCs are aggregated by the UE, the
20 aggregating pattern is indicated by the eNB, or predefined.

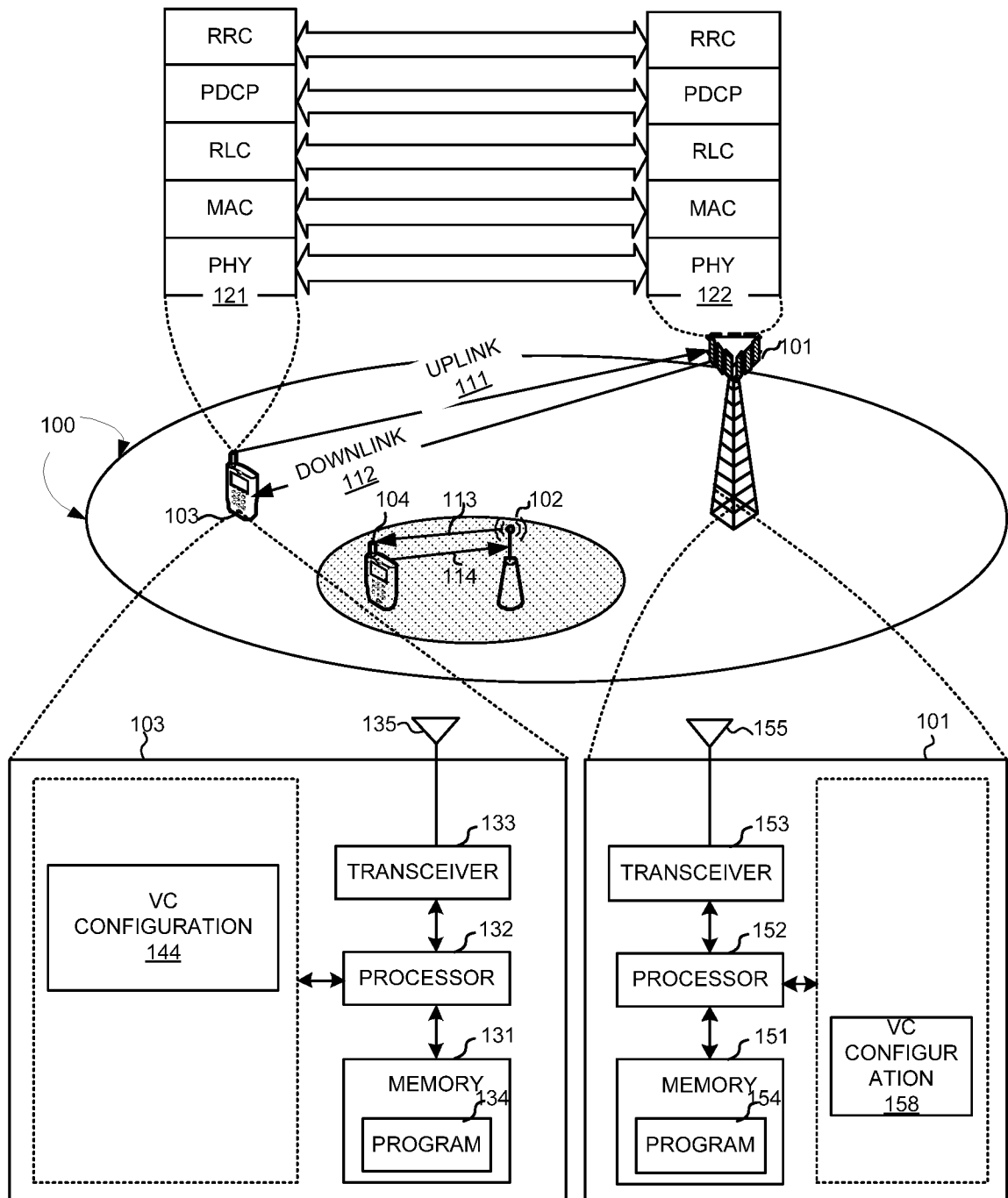


FIG. 1

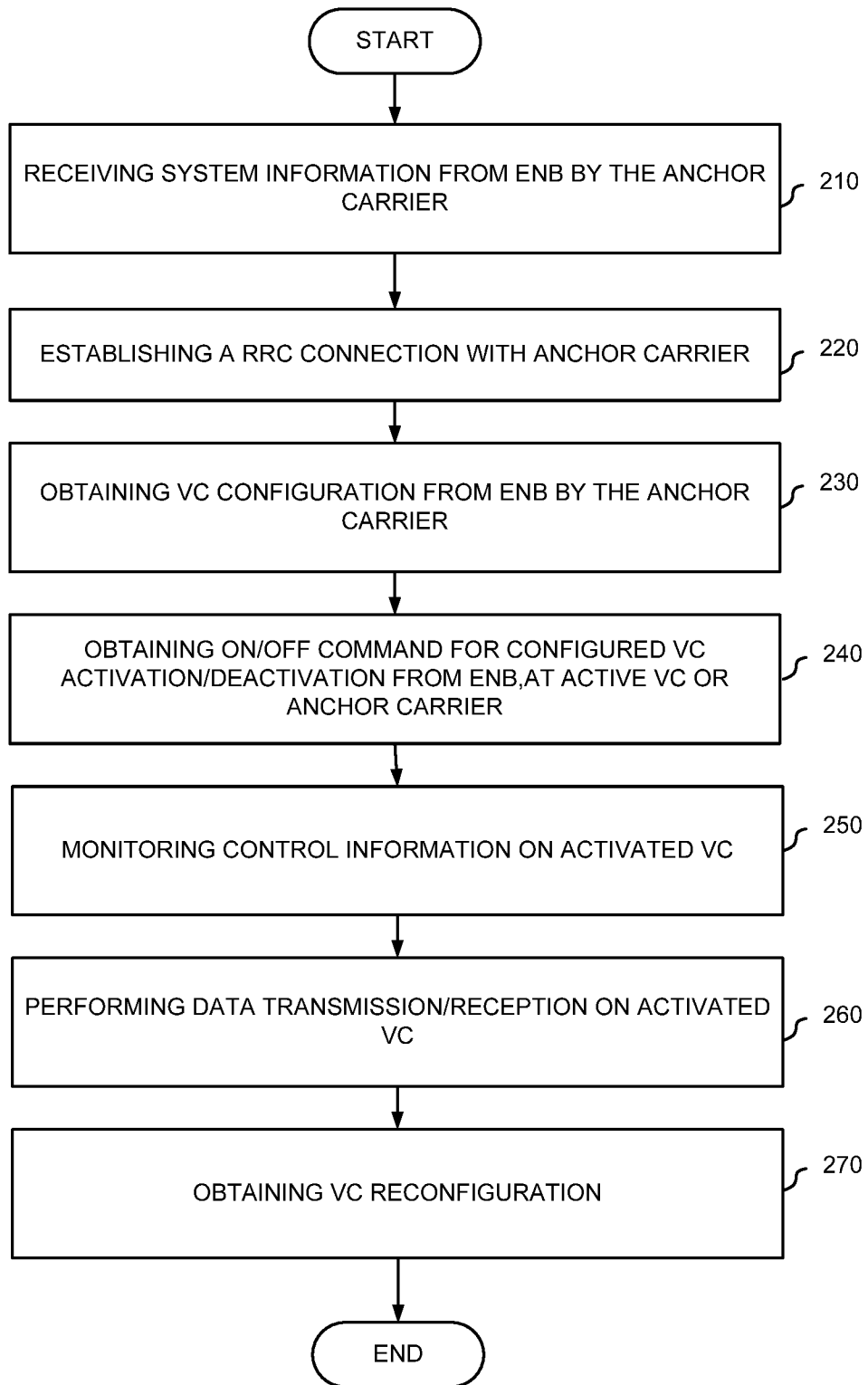


FIG. 2

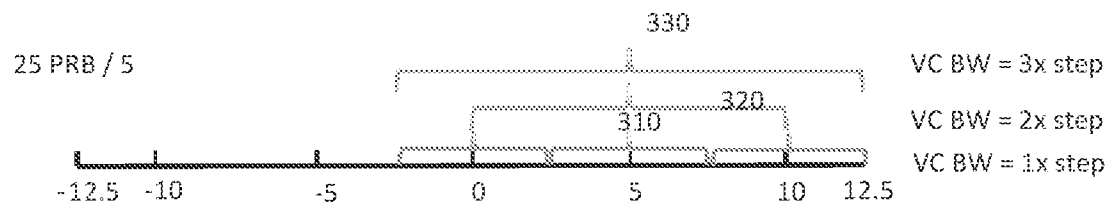


FIG. 3A

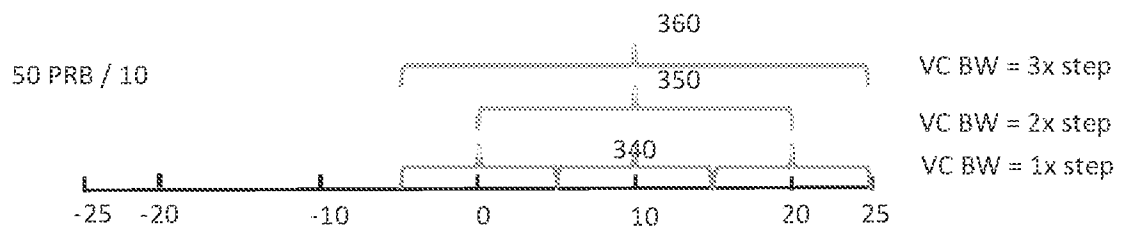


FIG. 3B

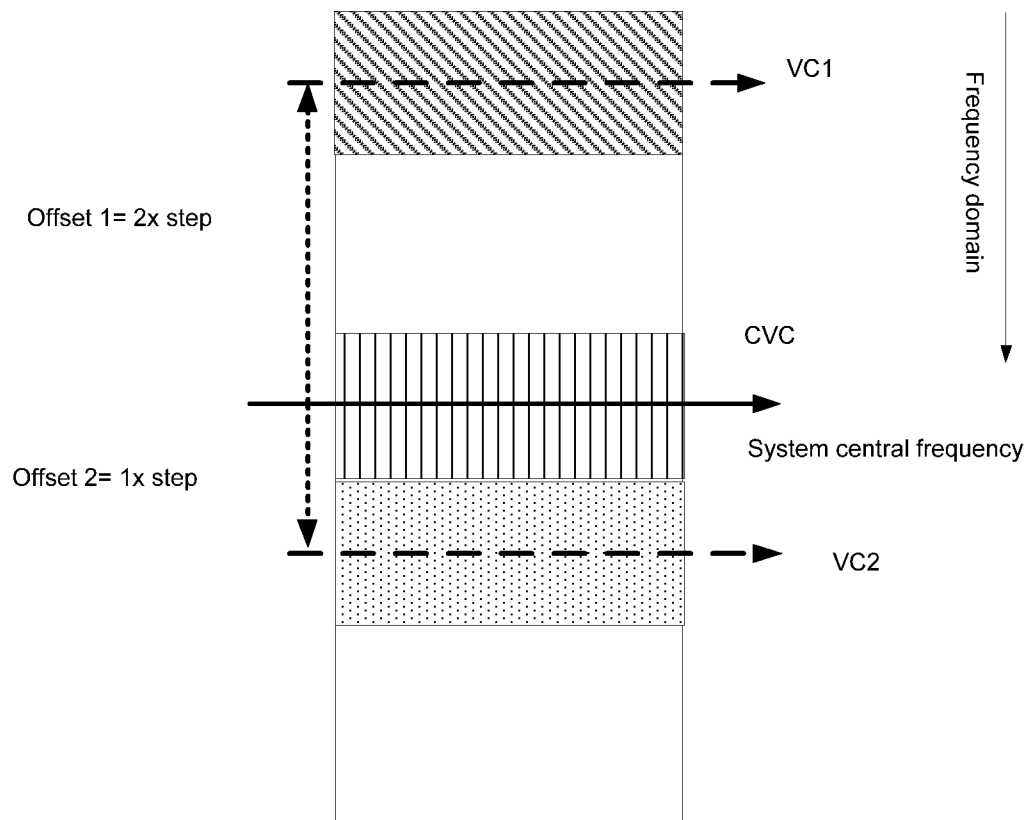


FIG. 4A

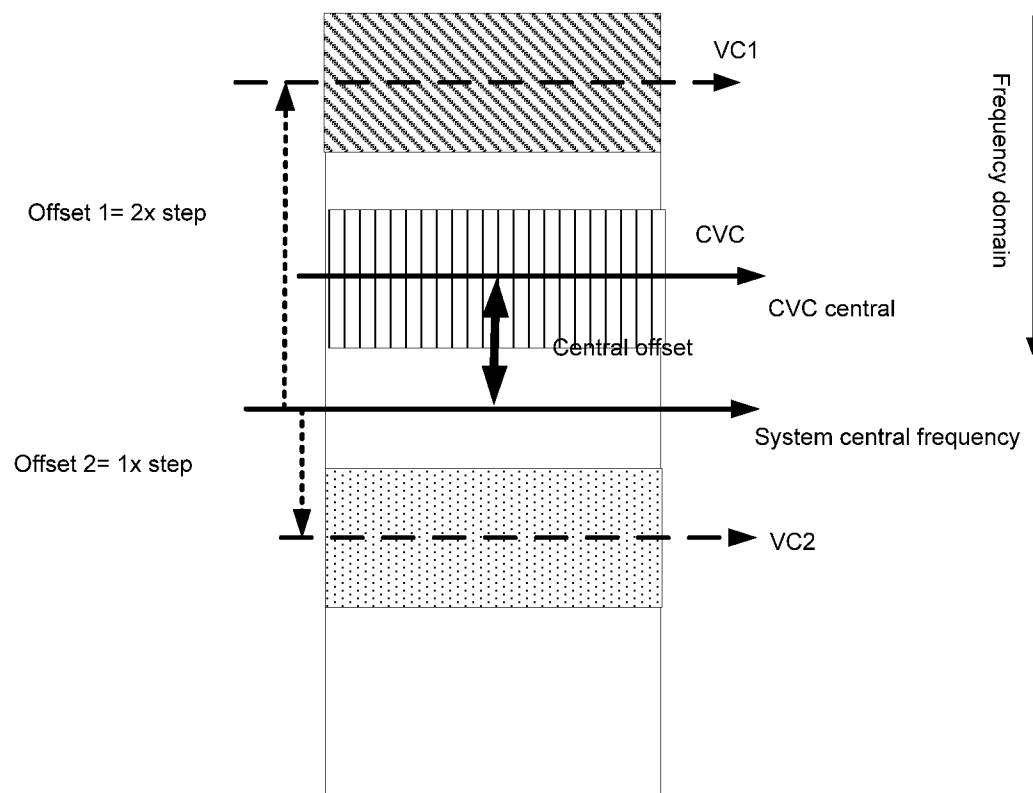


FIG. 4B

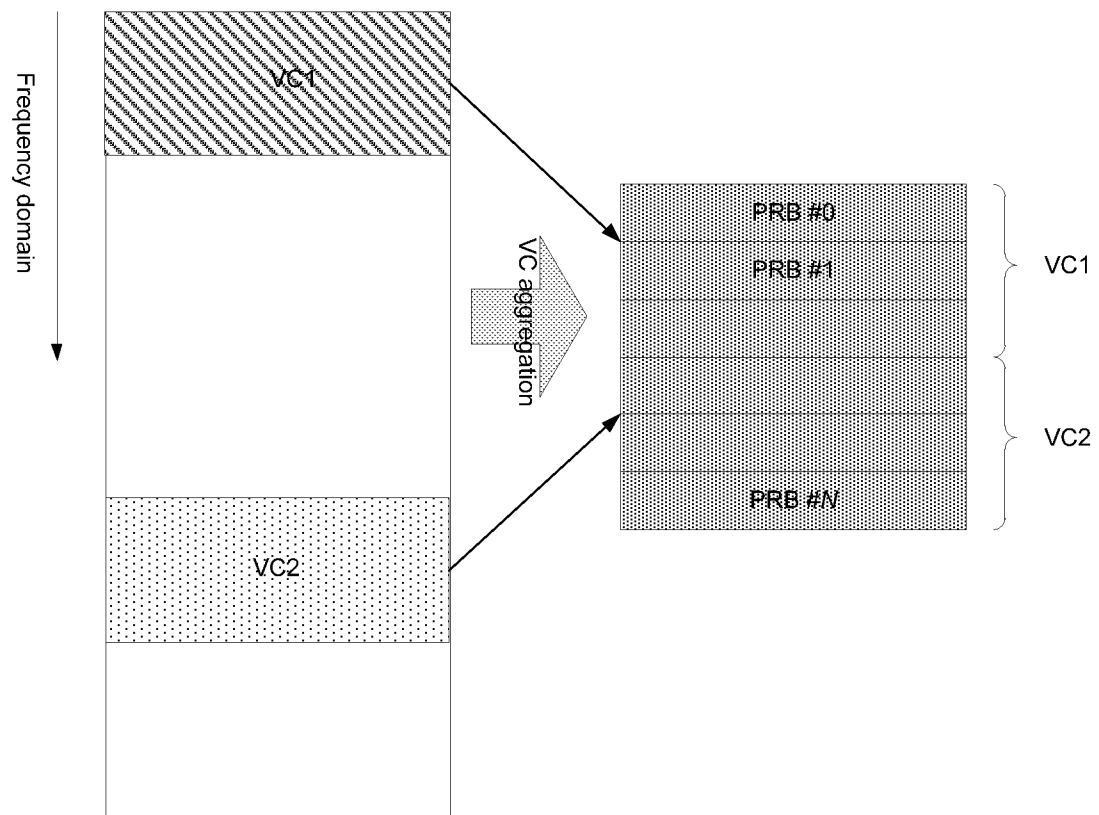


FIG. 5A

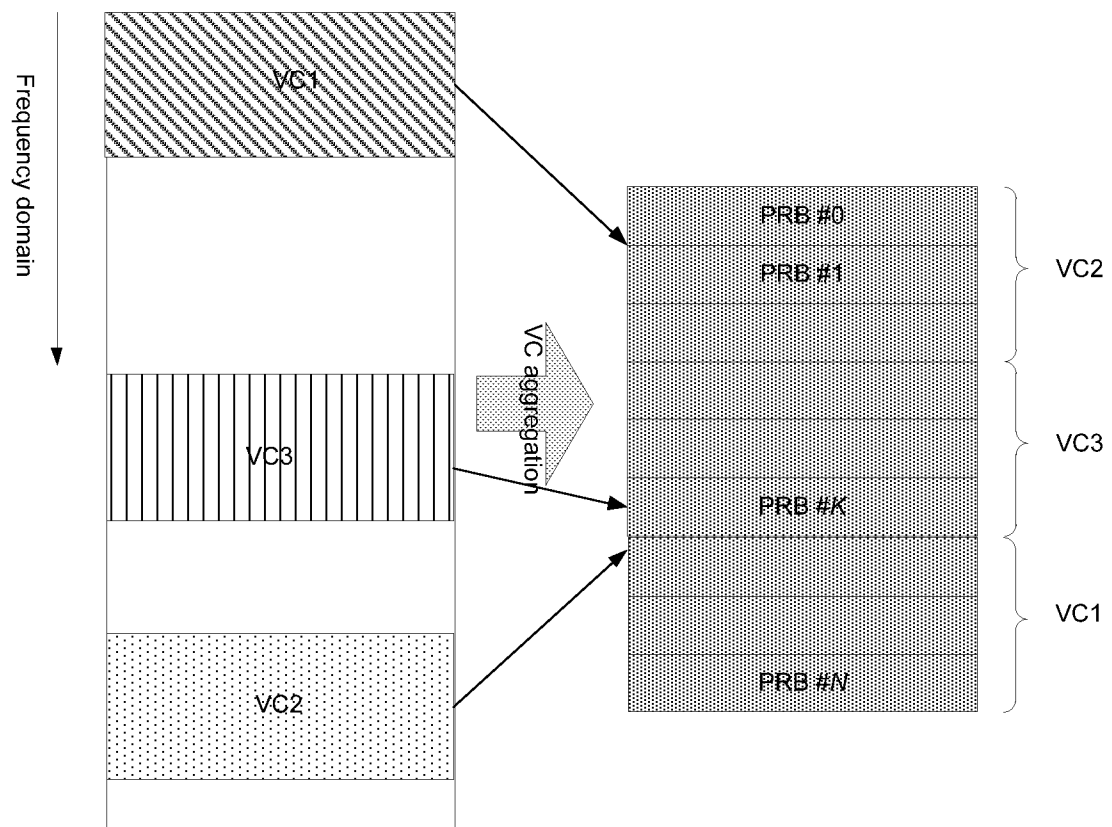


FIG. 5B

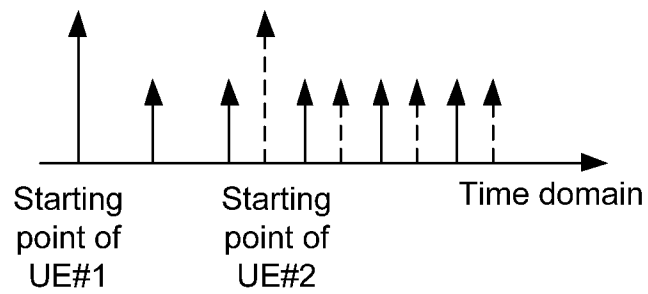


FIG. 6A

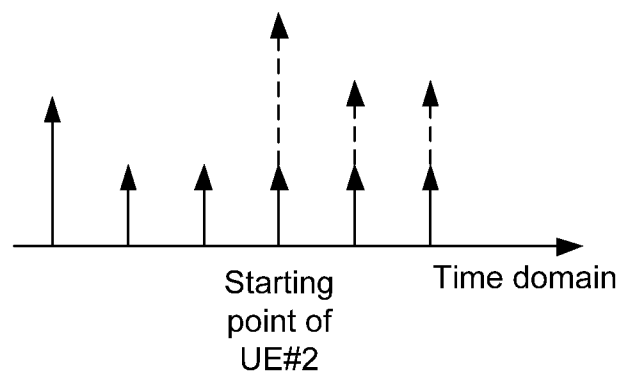


FIG. 6B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/094871

A. CLASSIFICATION OF SUBJECT MATTER

H04L 5/00(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;H04W

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)

WPI,EPODOC,CNPAT,CNKI 3GPP:virtual carrier, VC, RRC, configur+, aggregat+, multi w carrier, offset, resource, block, RB, CSI, CQI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015022091 A1 (SONY CORP. ET AL.) 19 February 2015 (2015-02-19) description, page 13 line 3 to page 20 line 25, figure 6	1-5, 7
Y	WO 2015022091 A1 (SONY CORP. ET AL.) 19 February 2015 (2015-02-19) description, page 13 line 3 to page 20 line 25, figure 6	6
Y	WO 2015062887 A2 (SONY CORP. ET AL.) 07 May 2015 (2015-05-07) description, page 3 lines 26 to 42, figures 6 to 8	6
A	US 2015195787 A1 (SONY CORP.) 09 July 2015 (2015-07-09) the whole document	1-7
A	HUAWEI et al. "Further aspects of NCT" 3GPP TSG RAN WG1 Meeting #72bis R1-130875, 19 April 2013 (2013-04-19), section 3.2	1-7



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

14 March 2017

Date of mailing of the international search report

30 March 2017

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/094871

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				KR	20160043961	A	22 April 2016
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US	2015195787	A1	09 July 2015	EP	2893751	A1	15 July 2015
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				JP	2015529426	A	05 October 2015