



(51) International Patent Classification:
H04W 16/02 (2009.01)

(21) International Application Number:
PCT/CN2013/070374

(22) International Filing Date:
11 January 2013 (11.01.2013)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **EMPIRE TECHNOLOGY DEVELOPMENT LLC** [US/US]; 2711 Centerville Road, Suite 400, Wilmington, Delaware 19808 (US).

(72) Inventor; and

(71) Applicant (*for US only*): **HUANG, Anpeng** [CN/CN]; Room 201, Building 6Yi, Yandong Yuan, Qinghua South Road, Haidian District, Beijing 100084 (CN).

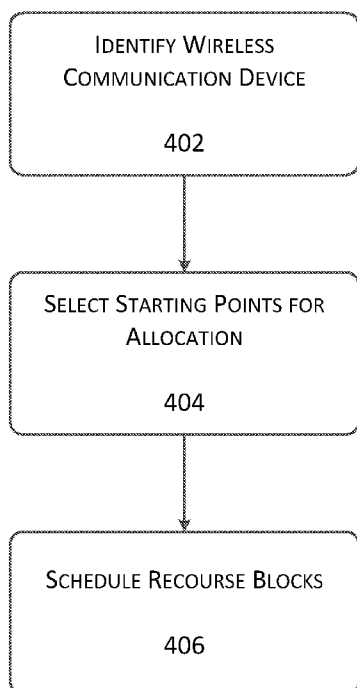
(74) Agent: **BELJING SANYOU INTELLECTUAL PROPERTY AGENCY LTD.**; 16th Fl., Block A, Corporate Square, No.35 Jinrong Street, Beijing 100033 (CN).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU,

[Continued on next page]

(54) Title: ELIMNATING CROSSED TIMESLOTS INTERFERENCE

400



(57) Abstract: In an example embodiment, one or more scheduler of base stations may be configured to schedule resource blocks on a frequency band of two adjacent cells to eliminate crossed timeslots interference by selecting different starting points on the frequency band.

FIG. 4



RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

Published:

— *with international search report (Art. 21(3))*

ELIMINATING CROSSED TIMESLOTS INTERFERENCE

TECHNICAL FIELD

The embodiments described herein pertain generally to implementing a scheduling mechanism to eliminate crossed timeslots interference under time-division duplexing (TDD) mode.

BACKGROUND

For TDD mode, isolation of upstream and downstream channels is realized by time division. Crossed timeslots may cause strong interference when a same sub-frame is allocated to two different terminal devices that are both using a same frequency band.

SUMMARY

In one example embodiment, a method may include identifying a first wireless communication device that is within a predetermined range of an edge of a first cell and an edge of a second cell that is adjacent to the first cell, selecting a first starting point for allocation of resource blocks in the first cell for the first wireless communication device that is different from a second starting point utilized by the second cell, and scheduling resource blocks for the first wireless communication device by starting at the first starting point.

In another example embodiment, a computer-readable medium storing instructions that, when executed, may cause one or more processors to perform operations comprising selecting a first starting point for allocation of resource blocks in a first cell for a first wireless communication device that is different than a second starting point utilized by a second cell that is adjacent to the first cell, and scheduling resource blocks for the first wireless communication device by starting at the first starting point.

In yet another example embodiment, a computer-readable medium storing instructions that, when executed, may cause one or more processors to perform operations comprising identifying a first wireless communication device and a second wireless communication device that are near an edge of a first cell and an edge of a second cell adjacent to the first cell, selecting a first starting point for allocation of resource blocks in the first cell for the first

wireless communication device and selecting a second starting point for allocation of resource blocks in the second cell for the second wireless communication device such that the first starting point utilized by the first cell and the second starting point utilized by the second cell are different, scheduling resource blocks for the first wireless communication device by starting
5 at the first starting point, and scheduling resource blocks for the second wireless communication device by starting at the second starting point.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and
10 the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the detailed description that follows, embodiments are described as illustrations only since various changes and modifications will become apparent to those skilled in the art from
15 the following detailed description. The use of the same reference numbers in different figures indicates similar or identical items.

FIG. 1 shows an example wireless communication system in which one or more embodiments of eliminating crossed timeslots interference may be implemented, arranged in accordance with at least some embodiments described herein;

FIG. 2 shows an example base station by which one or more embodiments of eliminating crossed timeslots may be implemented, arranged in accordance with at least some
20 embodiments described herein;

FIG. 3 shows an example scheduler by which at least portions of one or more embodiments of eliminating crossed timeslots may be implemented, arranged in accordance
25 with at least some embodiments described herein;

FIG. 4 shows an example configuration of a processing flow of operations for which embodiments of eliminating crossed timeslots may be implemented, arranged in accordance with at least some embodiments described herein;

FIG. 5 shows an example frequency band in accordance with one or more embodiments of eliminating crossed timeslots, arranged in accordance with at least some embodiments described herein; and

FIG. 6 shows a block diagram illustrating an example computing device by which various example solutions described herein may be implemented, arranged in accordance with at least some embodiments described herein.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings, which form a part of the description. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. Furthermore, unless otherwise noted, the description of each successive drawing may reference features from one or more of the previous drawings to provide clearer context and a more substantive explanation of the current example embodiment. Still, the example embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein and illustrated in the drawings, may be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

FIG. 1 shows an example wireless communication system 100 in which one or more embodiments of eliminating crossed timeslots interference may be implemented, arranged in accordance with at least some embodiments described herein. As depicted, wireless communication system 100 includes, at least, a cell 114 bounded by edge 110, a base station 102 bounded by edge 110 within cell 114, a cell 116 bounded by edge 112, a base station 104 bounded by edge 112 within cell 116, a wireless communication device 106, and a wireless communication device 108. Base station 102 may be installed at a fixed location within the boundaries of cell 114 and, similarly, base station 104 may be installed at a fixed location within

the boundaries of cell 116. Further, base station 102 may transmit wireless signals for wireless communication device 106 when it is located within the boundaries marked by edge 110, and, similarly, base station 104 may transmit wireless signals for wireless communication device 108 when it is located within the boundaries marked by edge 112.

5 For example, cell 114 and cell 116 may each refer to a range of radio coverage in a respective cellular network. Cell 114 and cell 116 may each be configured, by a common entity or by separate entities, to provide wireless communication for wireless communication devices therein, and may further be equipped with base station 102 and base station 104 respectively. Wireless communications supported by base station 102 and base station 104 may include any
10 mobile communication technology, *e.g.*, Global System for Mobile Communications (GSM), Code Division Multiple Access (CDMA), *etc.*, depending upon the technologies supported by particular wireless service providers. For example, base station 102 may follow protocols of GSM when base station 104 may follow standards of CDMA. Such example protocols are not intended to be limiting, and therefore should not be interpreted to be so. Each cell may be
15 assigned with a unique identification in the cellular network.

Base station 102 and base station 104 may each be configured to support electronic communication between one or more wireless communication devices located within a corresponding cell, *e.g.*, wireless communication device 106 and wireless communication device 108, and one or more other wireless communication device that may be supported by
20 another base station disposed in another cell. Such communication may be in accordance with different wireless communication standards including Time Division Duplexing Long Term Evolution (TDD-LTE), Frequency Division Duplexing FDD-LTE, IEEE 802.15.4, Global System for Mobile Communications (GSM), Code Division Multiple Access (CDMA) and *etc.*, which may further determine the work mode of the respective wireless communication devices. The work
25 modes may include time division duplexing mode and frequency division duplexing mode. Such examples are not intended to be limiting, and therefore should not be interpreted to be so.

Edge 110 and edge 112 may each define the outer boundary of a working range of cell 114 and cell 116, respectively. Wireless communication devices within the working range of base stations 102 and 104 may reliably communicate with the respective base station.

However, the working range may not be fixed, depending on a number of factors including, but not limited to, surrounding terrain, the frequency of signals in use, and the required data rate of the respective wireless communication devices. Further, working ranges of two adjacent cells may be overlapping. Each of the wireless communication devices within the working range of
5 corresponding cells may be assigned with identifiers that indicate, at least, the cell to which it belongs.

Wireless communication device 106 and wireless communication device 108 may refer to a mobile (or portable) electronic device such as a mobile phone, smartphone, personal digital assistant (PDA) a personal media player device, an application specific device, or a hybrid
10 device that includes any of the above functions. Alternatively, at least one of wireless communication device 106 and wireless communication device 108 may be implemented as a personal computer including tablet, laptop computer, non-laptop computer configure configurations, etc. As depicted in FIG. 1, wireless communication device 106 and wireless communication device 108 may be located in an overlapping working range of cell 114 and cell
15 116 and may be configured to transmit signals to base station 102 and base station 104 respectively.

In an example embodiment, wireless communication device 106 and wireless communication device 108 may work under time-division duplexing (TDD) mode. Non-limiting examples of systems using time-division duplexing mode include UMTS 3G, TD-LTE, TD-SCDMA,
20 IEEE 802.16 WiMAX. Under time-division duplexing mode, a time domain may be divided into several recurrent timeslots having a fixed length. Further, a same timeslot may be allocated for downstream traffic and upstream traffic to different wireless communication devices, which may further cause interference among wireless communication devices. For example, therefore, when wireless communication device 106 and wireless communication device 108 are both
25 within the overlapping area of the working ranges of cell 114 and cell 116, base station 102 may allocate a timeslot to the downstream traffic of wireless communication device 106 while base station 104 may allocate the same timeslot to the upstream traffic of wireless communication device 108. If both the downstream link of wireless communication device 106 and the

upstream link of wireless communication device 108 are using a same resource block (*i.e.*, a section of bandwidth resource) it may cause interference.

Thus, **FIG. 1** shows an example wireless communication system 100 in which one or more embodiments of scheduling for eliminating crossed timeslots may be implemented.

5 **FIG. 2** shows an example base station by which one or more embodiments of eliminating crossed timeslots may be implemented, arranged in accordance with at least some embodiments described herein. As depicted, the base station may refer to either base station 102 or base station 104, and therefore, unless a distinction is needed for the purpose of the description, reference may be made to "base station 102/104." As further depicted, base
10 station 102/104 may include an antenna 202, a scheduler 204, and a transceiver 206.

Antenna 202 may be configured to convert electric power into electromagnetic waves, and vice versa, and then to transmit signals for wireless communication. When transmitting radio signals, antenna 202 may radiate energy from an oscillating radio frequency electric current as electromagnetic waves. When receiving radio signals, antenna 202 may intercept
15 some of the power of electromagnetic waves to produce a relative lower voltage at its terminals, which may be further amplified.

Scheduler 204 may be configured to adopt a timeslot structure from those defined by wireless communication standards implemented by base station 102/104. For example, 3rd Generation Partnership Program (3GPP) has defined seven timeslot structures for TD-LTE. Each
20 timeslot structure defines the upstream portions and the downstream portions within a given period of time. For example, timeslot structure #1 may define the first 70% of a given time period shall be used for upstream and the remaining 30% shall be used for downstream. Scheduler 204 may select one of the defined timeslot structures and further allocate timeslots of a time domain. The base stations of two or more adjacent cells (*e.g.*, base station 102/104)
25 may adopt the same timeslot structure; however, in this case, the frequency bandwidth resource for the two cells may not be fully utilized. The base stations may also choose timeslot structures based on the respective upstream/downstream traffic ratio, which may, however, cause crossed timeslots interference. Further, scheduler 204 may also be configured to allocate

resource blocks of a frequency band to each base station, or further, to each individual wireless communication device.

Transceiver 206 may be configured to, in transmission, transform digital or analog signals into a radio frequency electric current. In reception, transceiver 206 may be configured to transform the low voltage on the terminals of antenna 202 into digital or analog signals.

Thus, **FIG. 2** shows an example base station 102/104 by which one or more embodiments of scheduling for eliminating crossed timeslots may be implemented.

FIG. 3 shows an example configuration 300 of scheduler 204 by which at least portions of one or more embodiments of eliminating crossed timeslots may be implemented, arranged in accordance with at least some embodiments described herein. As depicted, scheduler 204 may include a device locator 302 and a resource allocator 304.

Device locator may be configured to retrieve the identification information of wireless communication device 106/108 and cell 114/116 and may further determine whether the respective wireless communication device is within the working range of a respective one of cell 114 or cell 116. The respective one or more identifiers of wireless communication device 106/108 and cell 114/116 may be transmitted to resource allocator 304.

Resource allocator 304 may be configured to eliminate interference by dispersing mapping of time frequency. That is, resource allocator 304 may allocate blocks on a frequency band or timeslots on a time domain in accordance with the retrieved identification of the respective wireless communication devices retrieved by device locator 102.

In accordance with the LTE standard, individual wireless communication devices may be scheduled to occupy a section of sub-carrier wave of a frequency band. When wireless communication device 106 and wireless communication device 108 share a same time domain (*i.e.*, the crossed timeslots of the adjacent base station), resource allocator 304 may realize dispersed mapping of frequency band by LTE scheduling algorithm. In one example embodiment, resource allocator 304 may allocate the resource blocks on a user-based scheduling algorithm by which portions of the resource blocks may be allocated to each individual wireless communication device in view of fairness. Each individual may then be allocated with one or more resource blocks proportionate to its traffic needs. Alternatively,

each individual may gain equal portions of the resource blocks. In yet another example embodiment, resource allocator 304 may allocate the resource blocks based on a channel-based scheduling algorithm (*e.g.*, maximum carrier-to-interference scheduling) to pursue the maximum throughput ratio of wireless communication system 100. Further, resource allocator
5 304 may adopt other algorithms to prevent the crossed timeslots interference instead of eliminating or mitigating the interference.

Thus, **FIG. 3** shows an example configuration 300 of an example scheduler 204 in which one or more embodiments of scheduling for eliminating crossed timeslots may be implemented.

FIG. 4 shows an example configuration of a processing flow 400 of operations for which
10 embodiments of eliminating crossed timeslots may be implemented, arranged in accordance with at least some embodiments described herein. As depicted, processing flow 400 may include sub-processes executed by various components that are part of wireless communication system 100. However, processing flow 400 is not limited to such components, as obvious modification may be made by re-ordering two or more of the sub-processes
15 described here, eliminating at least one of the sub-processes, adding further sub-processes, substituting components, or even having various components assuming sub-processing roles accorded to other components in the following description. Processing flow 400 may include various operation, functions, or actions as illustrated by one or more of blocks 402, 404, and/or 406. Processing may begin at block 402.

20 Block 402 (Identify Wireless Communication Device) may refer to device locator 302 identifying wireless communication device 106 and wireless communication device 108, and determining that wireless communication device 106 and wireless communication device 108 are within a predetermined range of edge 110 of cell 114 and edge 112 of cell 116. The one or more identifiers of wireless communication device 106/108 and cell 114/116 may be
25 transmitted to resource allocator 304. Processing may continue from block 402 to block 404.

Block 404 (Select Starting Points for Allocation) may refer to resource allocator 304 selecting a first starting point for allocation of resource blocks for communication between wireless communication device 106 in cell 114 and a different second starting point for

allocation for communication between wireless communication device 108 in cell 116. The resource blocks may be created by evenly dividing frequency band of cell 114 and cell 116.

In one example embodiment, resource allocator 304 may utilize a hashing function to select the first starting point. The hashing function may map an identification of cell 114 with a certain starting point of the resource block. In another example embodiment, the hashing function may map an identification of wireless communication device 106/108 with a starting point of the resource blocks. More particularly, identification of cell 114/116 or wireless communication device 106/108 may be utilized as an input of the hashing function, and the output of hashing function may be a fixed value. For a given hash value, there may be one corresponding input value of the hashing function. Thus, two wireless communication devices or two cells may not be allocated to a same resource block. However, in yet another example embodiment, resource allocator 304 may simply adopt an algebraic formulation to select the first starting point. For example, resource allocator may select the second starting point with ten resource blocks away from the first starting point. Processing may continue from block 404 to block 406.

Block 406 (Schedule Resource Blocks) may refer to resource allocator 304 scheduling resource blocks for wireless communication device 106 by starting at the first starting point. Resource allocator 304 may further adopt scheduling algorithms in accordance with existing wireless communication standards.

Thus, **FIG. 4** shows an example configuration of a processing flow 400 of operations for scheduling for eliminating crossed timeslots may be implemented.

FIG. 5 shows an example frequency band 500 in accordance with one or more embodiments of eliminating crossed timeslots, arranged in accordance with at least some embodiments described herein. As depicted, example frequency band 500 includes a frequency band 506 and resource blocks 502A – 502N. Frequency band 506 may be used for wireless communication by cell 114 and cell 116.

Frequency band 506 may represent the total bandwidth that cell 114/116 may use for communication. In one example embodiment, since LTE standard adopts packet switching network based on Orthogonal Frequency-division Multiplexing (OFDM) technology, each

wireless communication device uses a section of sub-carrier wave of a frequency band (*i.e.*, a resource block). For example, when base station 102/104 is allocated with 20M bandwidth, which is further divided into one hundred resource blocks, wireless communication devices 106/108 within the working range of the corresponding cell share the 20M bandwidth and each device uses portions of the total bandwidth. As to a specific wireless communication device allocated with 3M bandwidth, it may be allocated with 15 resource blocks.

In at least one example embodiment, in which scheduler 204 may input the identification of cell 114 to a hashing function; the output value (*i.e.*, first starting point on frequency band 506) of the hashing function may be resource block 502A. The scheduler 204 may further schedule a series of resource blocks following 502A including 502B, 502C, and 502D to the one or more wireless communication devices within the working range of cell 114. Similarly, scheduler 204 may input the identification of cell 116 to the hashing function; the output value (*i.e.*, the second starting point on frequency band 506) of the hashing function may be resource block 502E. The resources blocks after 502E including 502F, 502G, and 502H may be allocated to the wireless communication devices within cell 116. The wireless communication devices in working range of two adjacent cells may then be allocated with different sub-carriers of the frequency band and may work on different frequencies. Thus, even when two or more wireless communication devices are working in the same timeslot, the crossed timeslots interference may be avoided.

In another example embodiment, scheduler 204 may input the identification of wireless communication device 106 to a hashing function; the output value may be a specific resource block on the frequency band, for example, 502F. In this example, wireless communication device 106 may then use the frequency defined by resource block 502F for its communication with base station 102. Because of the deterministic feature of hashing function, two different wireless communication devices having different identifiers may always be allocated to different resource blocks (*i.e.*, using different frequency). Thus, wireless communication devices within the working range of a same cell or within the working range of two different cells may avoid interfering with each other.

Thus, **FIG. 5** shows an example frequency band 500 of cell 114 and cell 116 in which one or more embodiments of scheduling for eliminating crossed timeslots may be implemented.

FIG. 6 shows a block diagram illustrating an example computing device by which various example solution described herein may be implemented, arranged in accordance with at least
5 some embodiments described herein.

More particularly, **FIG. 6** shows an illustrative computing embodiment, in which any of the processes and sub-processes described herein may be implemented as computer-readable instructions stored on a computer-readable medium. The computer-readable instructions may, for example, be executed by a processor of a device, as referenced herein, having a network
10 element and/or any other device corresponding thereto, particularly as applicable to the applications and/or programs described above corresponding to the example wireless communication system.

In a very basic configuration, a computing device 600 may typically include one or more processors 604 and a system memory 606. A memory bus 608 may be used for communicating
15 between processor 604 and system memory 606.

Depending on the desired configuration, processor 604 may be of any type including but not limited to a microprocessor (μ P), a microcontroller (μ C), a digital signal processor (DSP), or any combination thereof.

Depending on the desired configuration, system memory 606 may be of any type
20 including but not limited to volatile memory (such as RAM), non-volatile memory (such as ROM, flash memory, etc.) or any combination thereof. System memory 606 may include an operating system 620, one or more applications 622, and program data 624.

Application 622 may be configured to schedule to eliminate crossed timeslots interference as described previously with respect to **FIGS. 1 - 5**. Program data 624 may include
25 a table 650, which may be useful for implementing actuation of appropriate components or modules as described herein.

System memory 606 is an example of computer storage media. Computer storage media may include, but not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes,

magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which may be used to store the desired information and which may be accessed by computing device 600. Any such computer storage media may be part of computing device 600.

The network communication link may be one example of a communication media.

5 Communication media may typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and may include any information delivery media. A “modulated data signal” may be a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation,
10 communication media may include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), microwave, infrared (IR) and other wireless media. The term computer readable media as used herein may include both storage media and communication media.

There is little distinction left between hardware and software implementations of
15 aspects of systems; the use of hardware or software is generally (but not always, in that in certain contexts the choice between hardware and software can become significant) a design choice representing cost vs. efficiency tradeoffs. There are various vehicles by which processes and/or systems and/or other technologies described herein may be implemented, *e.g.*, hardware, software, and/or firmware, and that the preferred vehicle may vary with the context
20 in which the processes and/or systems and/or other technologies are deployed. For example, if an implementer determines that speed and accuracy are paramount, the implementer may opt for a mainly hardware and/or firmware vehicle; if flexibility is paramount, the implementer may opt for a mainly software implementation; or, yet again alternatively, the implementer may opt for some combination of hardware, software, and/or firmware.

25 The foregoing detailed description has set forth various embodiments of the devices and/or processes for wireless communication system 100 via the use of block diagrams, flowcharts, and/or examples. Insofar as such block diagrams, flowcharts, and/or examples contain one or more functions and/or operations, it will be understood by those within the art that each function and/or operation within such block diagrams, flowcharts, or examples can be

implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one embodiment, several portions of the subject matter described herein may be implemented via Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), digital signal processors (DSPs), or other integrated formats. However, those skilled in the art will recognize that some aspects of the embodiments disclosed herein, in whole or in part, can be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers, *e.g.*, as one or more programs running on one or more computer systems, as one or more programs running on one or more processors, *e.g.*, as one or more programs running on one or more microprocessors, as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and or firmware would be well within the skill of one of skill in the art in light of this disclosure. In addition, those skilled in the art will appreciate that the mechanisms of the subject matter described herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive, a CD, a DVD, a digital tape, a computer memory, etc.; and a transmission type medium such as a digital and/or an analog communication medium (*e.g.*, a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.).

Those skilled in the art will recognize that it is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to integrate such described devices and/or processes into data processing systems. That is, at least a portion of the devices and/or processes described herein can be integrated into a data processing system via a reasonable amount of experimentation. Those having skill in the art will recognize that a typical data processing system generally includes one or more of a system unit housing, a video display device, a memory such as volatile and non-volatile memory, processors such as microprocessors and digital signal processors, computational entities such as operating systems, drivers, graphical user interfaces, and applications programs,

one or more interaction devices, such as a touch pad or screen, and/or control systems including feedback loops and control motors, *e.g.*, feedback for sensing position and/or velocity; control motors for moving and/or adjusting components and/or quantities. A typical data processing system may be implemented utilizing any suitable commercially available components, such as those typically found in data computing/communication and/or network computing/communication systems.

The herein described subject matter sometimes illustrates different components contained within, or connected with, different other components. It is to be understood that such depicted architectures are merely examples, and that in fact many other architectures can be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated can also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

Lastly, with respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims, *e.g.*, bodies of the appended claims, are generally intended as "open" terms, *e.g.*, the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be

interpreted as "includes but is not limited to," *etc.* It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may

5 contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at

10 least one" and indefinite articles such as "a" or "an," *e.g.*, "a" and/or "an" should be interpreted to mean "at least one" or "one or more;" the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number, *e.g.*, the bare recitation of "two

15 recitations," without other modifiers, means at least two recitations, or two or more recitations. Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, *etc.*" is used, in general such a construction is intended in the sense one having skill in the art would understand the convention, *e.g.*, "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A

20 and C together, B and C together, and/or A, B, and C together, *etc.* In those instances where a convention analogous to "at least one of A, B, or C, *etc.*" is used, in general such a construction is intended in the sense one having skill in the art would understand the convention, *e.g.*, "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B,

25 and C together, *etc.* It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

From the foregoing, it will be appreciated that various embodiments of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various embodiments disclosed herein are not intended to be
5 limiting, with the true scope and spirit being indicated by the following claims.

WE CLAIM

1. A method, comprising:

identifying a first wireless communication device that is within a predetermined range of
5 an edge of a first cell and an edge of a second cell that is adjacent to the first cell;

selecting a first starting point for allocation of resource blocks in the first cell for the first
wireless communication device that is different from a second starting point utilized by the
second cell; and

scheduling resource blocks for the first wireless communication device by starting at the
10 first starting point.

2. The method as recited in Claim 1, wherein the selecting the first starting point
comprises selecting the first starting point using a hashing function.

15 3. The method as recited in Claim 1, wherein the selecting the first starting point
comprises selecting the first starting point using a hashing function with an identification of the
first cell as an input.

4. The method as recited in Claim 1, wherein the selecting the first starting point
20 comprises selecting the first starting point using a hashing function with an identification of the
first wireless communication device as an input.

5. The method as recited in Claim 2, wherein the hashing function is configured to map
identification information of the first wireless communication device with a first predetermined
25 starting point of the resource blocks.

6. The method as recited in Claim 2, wherein the hashing function is configured to map identification information of the first cell with a second predetermined starting point of the resource blocks.

5 7. The method as recited in Claim 1, wherein the selecting the first starting point comprises selecting the first starting point using an algebraic formulation.

8. The method as recited in Claim 1, further comprising:

10 identifying a second wireless communication device within a predetermined range of the edge of the first cell and the edge of the second cell;

 selecting the second starting point for allocation of resource blocks in the second cell for the second wireless communication device to be different from the first starting point utilized by the first cell; and

15 scheduling resource blocks for the second wireless communication device by starting at the second starting point.

9. The method as recited in Claim 8, wherein the selecting the second starting point comprises selecting the second starting point using a second hashing function with an identification of the second cell or an identification of the second wireless communication
20 device as an input to the second hashing function.

10. A computer-readable medium storing instructions that, when executed, cause one or more processors to perform operations, comprising:

25 selecting a first starting point for allocation of resource blocks in a first cell for a first wireless communication device that is different than a second starting point utilized by a second cell that is adjacent to the first cell; and

 scheduling resource blocks for the first wireless communication device by starting at the first starting point.

11. The computer-readable medium as recited in Claim 10, wherein the selecting the first starting point comprises selecting the first starting point using a hashing function.

12. The computer-readable medium as recited in Claim 10, wherein the selecting the first starting point comprises selecting the first starting point using a hashing function with an identification of the first cell as an input.

13. The computer-readable medium as recited in Claim 10, wherein the selecting the first starting point comprises selecting the first starting point using a hashing function with an identification of the first wireless communication device as an input.

14. The method as recited in Claim 11, wherein the hashing function is configured to map identification information of the first wireless communication device with a first predetermined starting point of the resource blocks.

15. The method as recited in Claim 11, wherein the hashing function is configured to map identification information of the first cell with a second predetermined starting point of the resource blocks.

16. The computer-readable medium as recited in Claim 10, wherein the selecting the first starting point comprises selecting the first starting point using an algebraic formulation.

17. The computer-readable medium as recited in Claim 10, further comprising:
identifying the first wireless communication device that is within a predetermined range of an edge of the first cell and an edge of the second cell, the first wireless communication device communicating in a time division duplex mode.

18. The computer-readable medium as recited in Claim 10, further comprising:

identifying a second wireless communication device that is within a predetermined range the edge of the first cell and the edge of the second cell;

selecting the second starting point for allocation of resource blocks in the second cell for the second wireless communication device to be different than the first starting point utilized by the first cell; and

scheduling resource blocks for the second wireless communication device by starting at the second starting point.

19. The computer-readable medium as recited in Claim 18, wherein the selecting the second starting point comprises selecting the second starting point using a second hashing function with an identification of the second cell or an identification of the second wireless communication device as an input to the second hashing function.

20. A computer-readable medium storing instructions that, when executed, cause one or more processors to perform operations comprising:

identifying a first wireless communication device and a second wireless communication device that are near an edge of a first cell and an edge of a second cell adjacent to the first cell;

selecting a first starting point for allocation of resource blocks in the first cell for the first wireless communication device and selecting a second starting point for allocation of resource blocks in the second cell for the second wireless communication device such that the first starting point utilized by the first cell and the second starting point utilized by the second cell are different;

scheduling resource blocks for the first wireless communication device by starting at the first starting point; and

scheduling resource blocks for the second wireless communication device by starting at the second starting point.

21. The computer-readable medium as recited in Claim 20, wherein the selecting the first starting point comprises selecting the first starting point using a hashing function.

22. The computer-readable medium as recited in Claim 21, wherein the first starting point is selected by using an identification of the first cell as an input to the hashing function.

5 23. The computer-readable medium as recited in Claim 21, wherein the first starting point is selected by using an identification of the first wireless communication device as an input to the hashing function.

24. The method as recited in Claim 22, wherein the hashing function is configured to
10 map identification information of the first wireless communication device with a first predetermined starting point of the resource blocks.

25. The method as recited in Claim 22, wherein the hashing function is configured to
map identification information of the first cell with a second predetermined starting point of the
15 resource blocks.

26. The computer-readable medium as recited in Claim 21, wherein the selecting the first starting point comprises selecting the first starting point using an algebraic formulation.

20

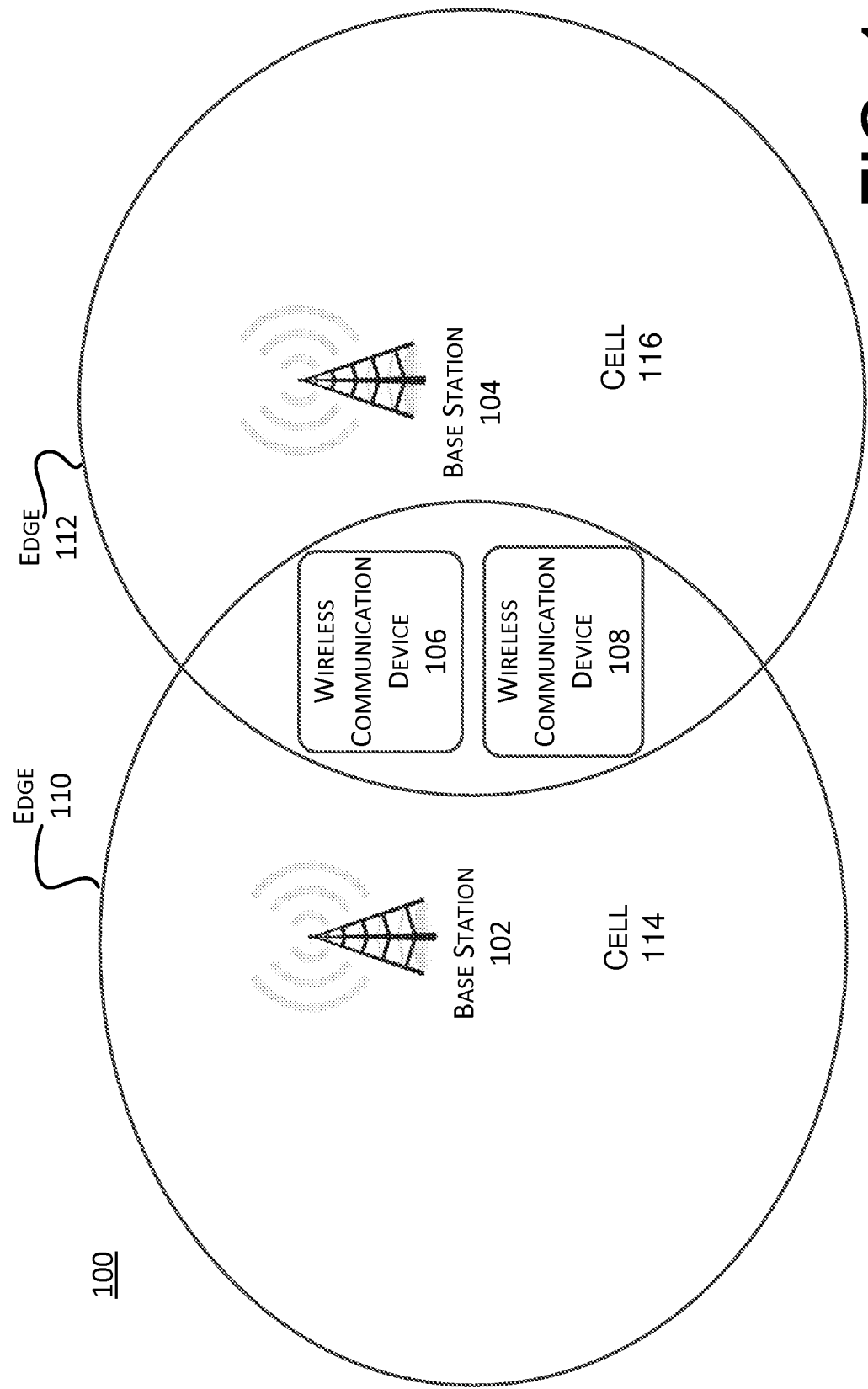


FIG. 1

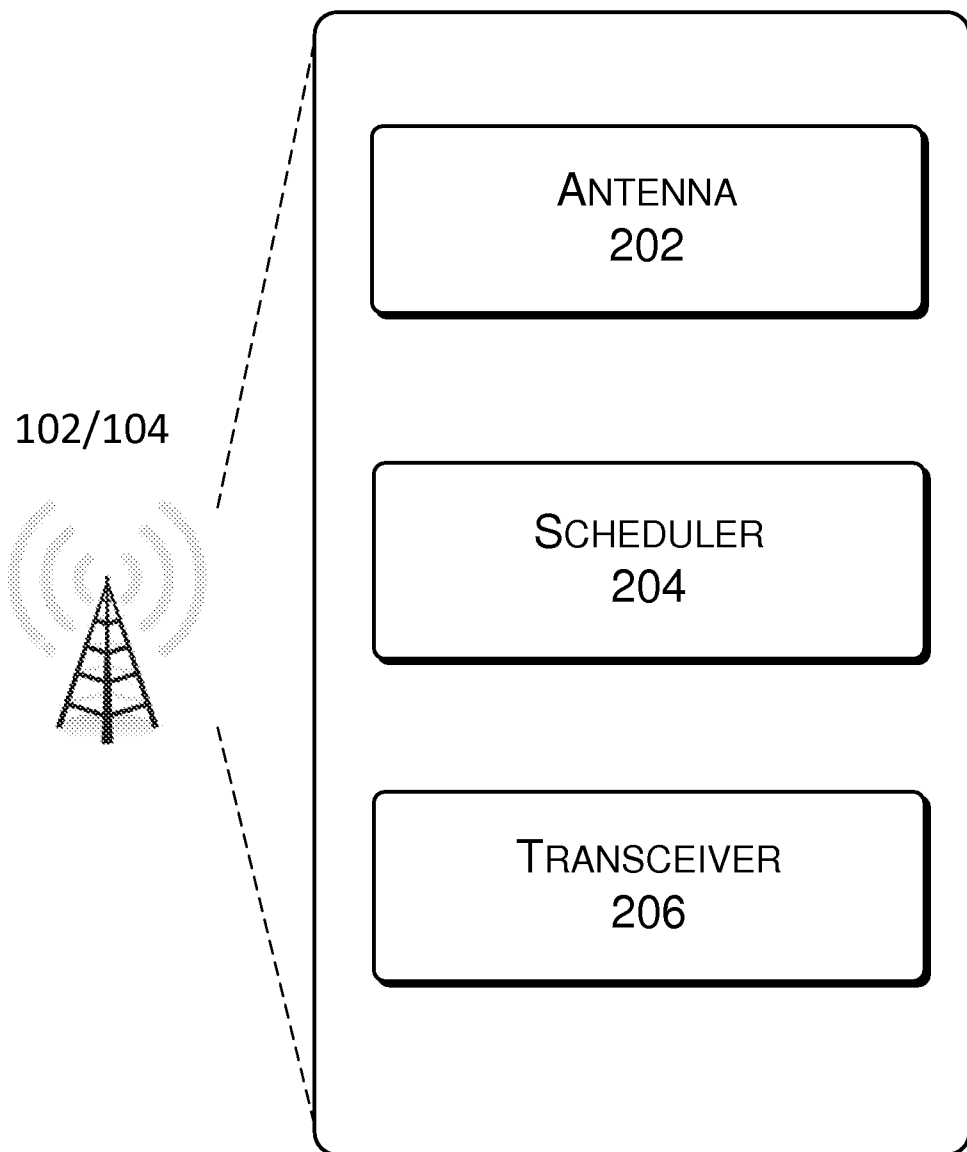
200

FIG. 2

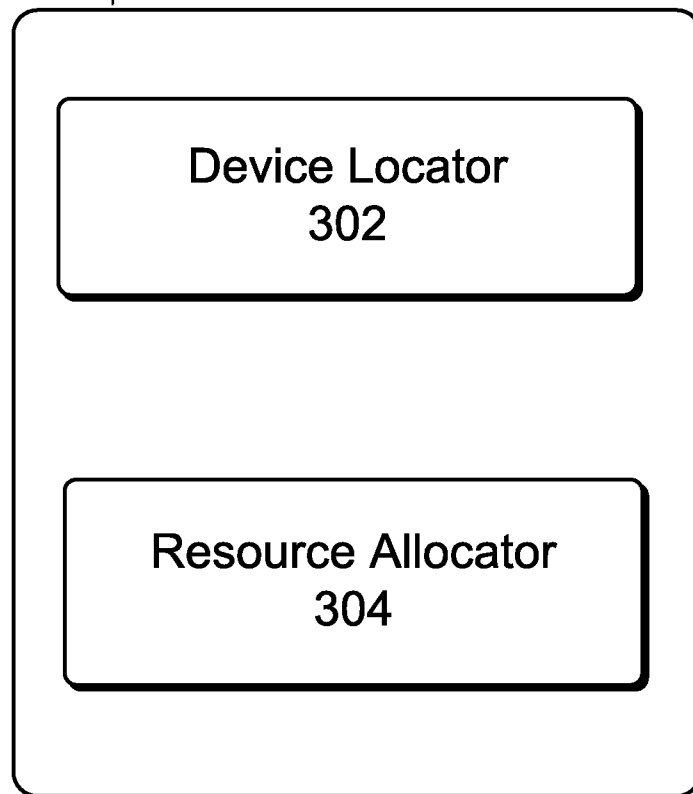
300204

FIG. 3

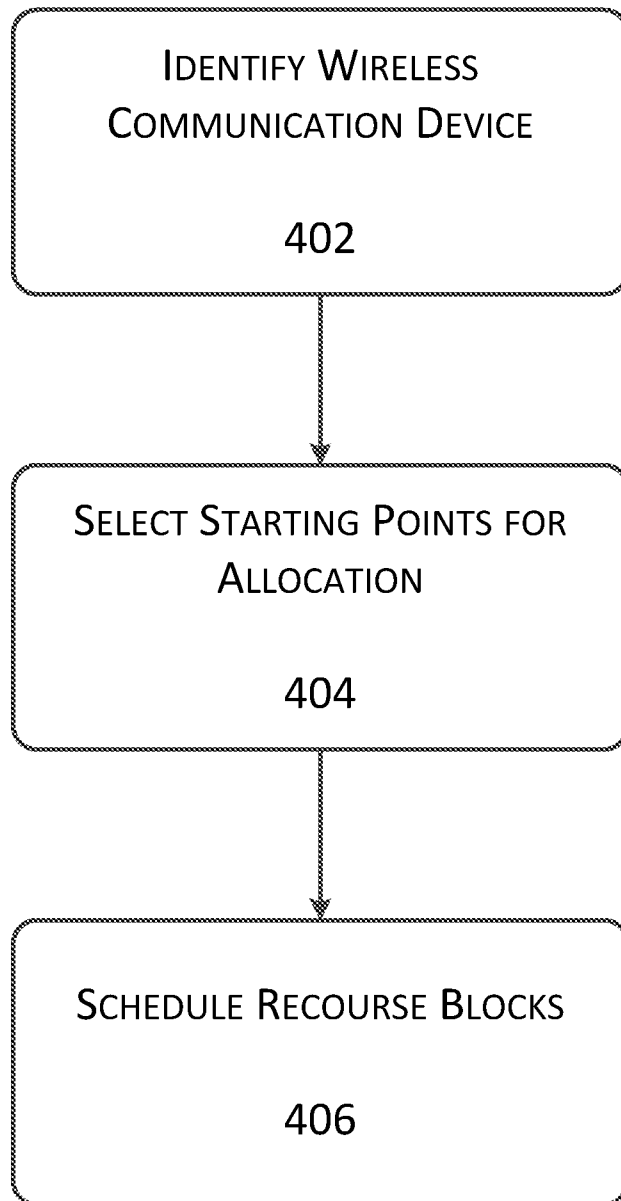
400

FIG. 4

500

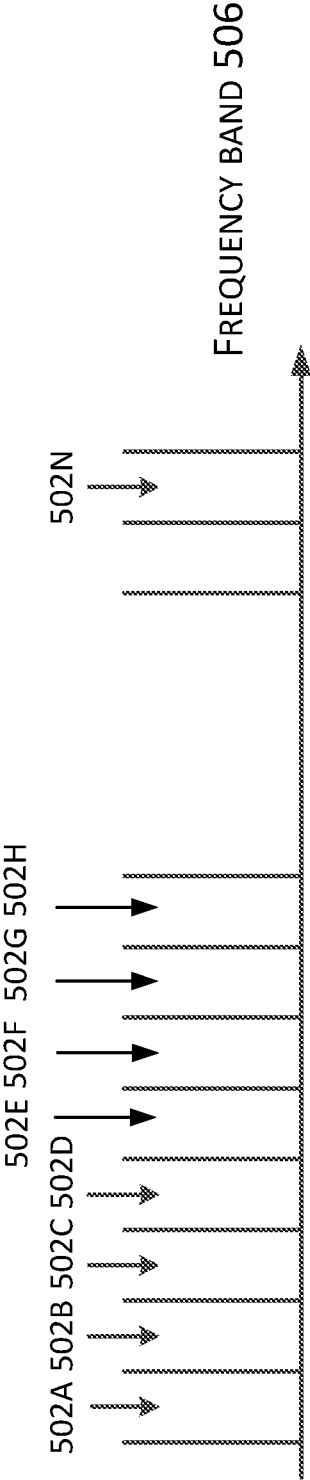


FIG. 5

COMPUTING DEVICE (600)

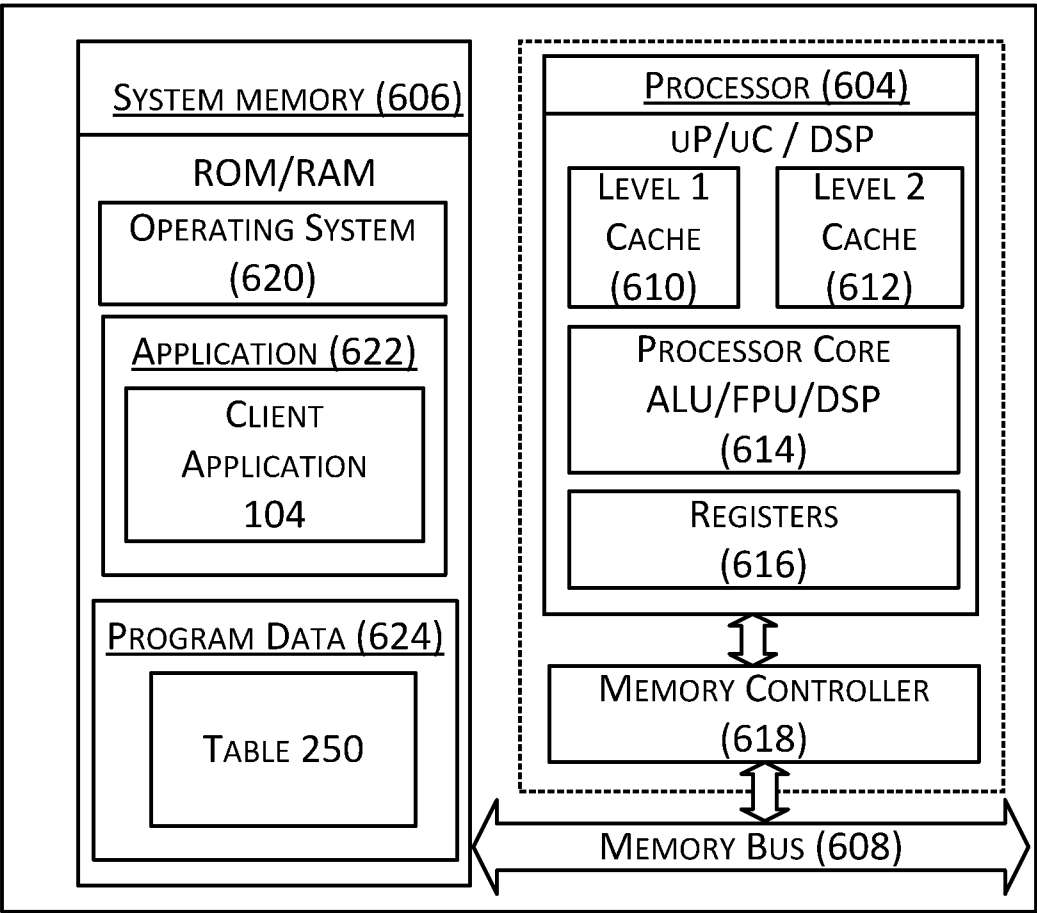


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/070374

A. CLASSIFICATION OF SUBJECT MATTER

H04W 16/02 (2009.01) 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)

IPC: H04W; H04L; H04N

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)

CNABS, CNTXT, CNKI, VEN: cell, first, second, adjacent, neighbor, neighbour, allocate, resource block, schedule, start, point, position

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101388697 A(ZTE CORP) 18 Mar. 2009(18.03.2009) description page 5, line 4 – page 6, line 3	1-26
A	CN 101981999 A(QUALCOMM INC) 23 Feb. 2011(23.02.2011) the whole document	1-26
A	CN 102726085 A(HUAWEI TECHNOLOGY CO LTD) 10 Oct. 2012(10.10.2012) the whole document	1-26

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

* Special categories of cited documents:	“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
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“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)	“&” document member of the same patent family
“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	

Date of the actual completion of the international search 27 Sep. 2013(27.09.2013)	Date of mailing of the international search report 17 Oct. 2013 (17.10.2013)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer LIU, Dan Telephone No. (86-10)62411509

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/070374

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 101388697 A	18.03.2009	CN 101388697 B	27.02.2013
CN 101981999 A	23.02.2011	TW 200948108 A	16.11.2009
		IN 201005624 P4	27.05.2011
		US 8442525 B2	14.05.2013
		WO 2009121010 A2	01.10.2009
		WO 2009121010 A3	14.01.2010
		KR 20100127865 A	06.12.2010
		JP 2011517190 A	26.05.2011
		US 2009247166 A1	01.10.2009
		EP 2266361 A2	29.12.2010
		KR 1175876 B1	21.08.2012
CN 102726085 A	10.10.2012	WO 2012103717 A1	09.08.2012