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(71) Applicant: **TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)** [SE/SE]; S-164 83 Stockholm (SE).

(72) Inventor; and
(71) Applicant *(for SC only)*: **LIU, Jinhua** [CN/CN]; No.5 Lize East Street, Chaoyang District, Beijing, 100102 (CN).

(72) Inventor: **FAN, Rui**; No.5 Lize East Street, Chaoyang District, Beijing, 100102 (CN).

(74) Agent: **CHINA PATENT AGENT (H.K.) LTD.**; 22/F., Great Eagle Center, 23 Harbour Road, Wanchai, Hong Kong (CN).

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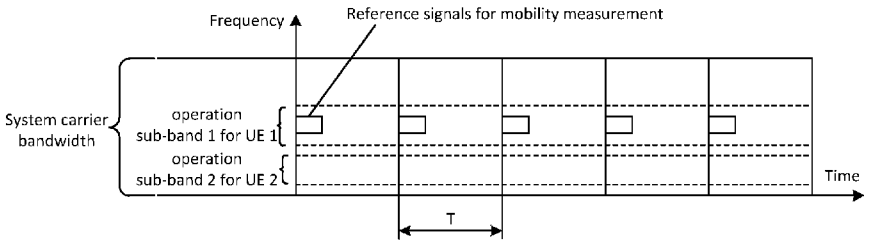

Fig.2

(57) Abstract: The embodiments disclose a method for a communication device switching among a plurality of sub-bands in a wireless network. The method comprises measuring a signal quality for an operation sub-band, comparing the signal quality with a signal quality threshold, determining a switch action according to the comparison of the signal quality with the signal quality threshold, and switching from the operation sub-band according to the determined switch action. The communication device and access node thereof are also disclosed.

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METHOD AND APPARATUS FOR MOBILITY MANAGEMENT

Technical Field

The present disclosure generally relates to a method for a mobility management procedure in wireless network and a communication device and an access node thereof.

Background

Nowadays, in order to meet the demand for ever increasing system capability and support a larger amount of communication devices, a system carrier bandwidth of a wireless communication network is growing broader and broader, from 100 MHz to 1 GHz, for example. In practice, not all the communication devices could support a full system carrier bandwidth due to hardware and cost restrictions. A communication device which supports a narrower frequency band could be configured to operate in a sub-band of the system carrier. Furthermore, not all the services require such a large system carrier bandwidth, therefore a communication device which supports a full system carrier bandwidth may also be configured to operate in a sub-band when its service only needs a narrower frequency bandwidth for power saving consideration, for example.

In practice, there may be a plurality of sub-bands for a system carrier in a wireless network, and reference signals for mobility measurement, such as Primary Synchronization Signal (PSS), Secondary Synchronization Signal (SSS) for Long Term Evolution (LTE) systems for example, are only transmitted over certain sub-bands out of the plurality of sub-bands. For a communication device operating in a sub-band without the reference signals for mobility measurement, since there are no reference signals for mobility measurement in its operation sub-band, a mobility measurement could be a problem for such a communication device.

A measurement gap for mobility measurement may be configured for a communication device, which is operating in a sub-band in which no reference signals for mobility measurement are transmitted. In the

configured measurement gap, there is no transmission and reception in the operation sub-band for the communication device, and the communication device measures the signal quality with respect to the reference sequences for mobility measurement and then switches back to the original operation sub-band for continuing data communication, resulting in a negative impact of considerable service interrupt and delay, which may be unacceptable for delay-sensitive services.

Summary

It is an object of the present disclosure to resolve or alleviate at least one of the problems mentioned above.

According to one aspect of the disclosure, there is provided a method in a communication device in a wireless network. The system carrier of the wireless network comprises a plurality of sub-bands, and reference signals for mobility measurement are transmitted in at least one of the plurality of sub-bands. The method comprises a step of measuring a signal quality for an operation sub-band, a step of comparing the signal quality with a signal quality threshold, a step of determining a switch action according to the comparison of the signal quality with the signal quality threshold and a step of switching from the operation sub-band according to the determined switch action.

According a further aspect of the disclosure, the operation sub-band of the communication device is a sub-band in which the reference signals for mobility measurement are not transmitted and the signal quality threshold is a first signal quality threshold. The step of switching from the operation sub-band according to the determined switch action further comprises a step of switching to a sub-band in which the reference signals for mobility measurement are transmitted in response to the comparison that the signal quality is lower than the first signal quality threshold.

According a further aspect of the disclosure, the operation sub-band of the communication device is a sub-band in which the reference signals for mobility measurement are transmitted, and the signal quality threshold

being a second signal quality threshold. The step of switching from the operation sub-band according to the determined switch action further comprises a step of switching to a sub-band in which the reference signals for mobility measurement are not transmitted in response to the comparison that the signal quality is higher than the second signal quality threshold.

According to one aspect of the disclosure, there is provided a method in an access node in a wireless network. The system carrier of the wireless network comprises a plurality of sub-bands, and reference signals for mobility measurement are transmitted in at least one of the plurality of sub-bands. The method comprises a step of determining whether a switch condition is satisfied for a communication device and a step of configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device.

According a further aspect of the disclosure, the step of determining whether a switch condition is satisfied further comprises a step of receiving a measurement report from the communication device, a step of determining a radio quality according to the measurement report and a step of comparing the radio quality with a radio quality threshold. The step of configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device further comprises a step of configuring the communication device with a switch action according to the comparison of the ratio quality with the radio quality threshold.

According a further aspect of the disclosure, an operation sub-band of the communication device is a sub-band in which the reference signals for mobility measurement are not transmitted, and the radio quality threshold is a first radio quality threshold. The step of configuring the communication device with a switch action according to the comparison result of the ratio quality with the radio quality threshold further comprises a step of configuring the communication device to switch to a sub-band in which the reference signals for mobility measurement are transmitted in

response to the comparison result that the radio quality being lower than the first radio quality threshold.

According a further aspect of the disclosure, an operation sub-band of the communication device is a sub-band in which the reference signals for mobility measurement are transmitted, and the radio quality threshold is a second radio quality threshold. The step of configuring the communication device with a switch action according to the comparison of the ratio quality with the radio quality threshold further comprises a step of configuring the communication device to switch to a sub-band in which the reference signals for mobility measurement are not transmitted in response to the comparison result that the radio quality being higher than the second radio quality threshold.

According a further aspect of the disclosure, the step of determining whether a switch condition is satisfied further comprising a step of measuring a load for a sub-band in which the reference signals for mobility measurement are transmitted, and a step of comparing the load with a load threshold. The step of configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device further comprises a step of selecting one or more communication devices operating in the sub-band in which the reference signals for mobility measurement are transmitted, and a step of configuring the one or more communication devices to switch to a sub-band in which the reference signals for mobility measurement are not transmitted.

Brief Description of the Drawings

Exemplary features of the present invention are set forth in the appended claims. However, the present invention, its implementation mode, other objectives, features and advantages will be better understood through reading the following detailed description on the exemplary embodiments with reference to the accompanying drawings, where in the drawings:

Fig. 1 schematically illustrates an exemplary flow diagram for a communication device switching from an operation sub-band for mobility measurement in a wireless network according to one or more embodiments of the present invention;

Fig. 2 schematically shows two exemplary communication devices operating in different sub-bands in a system carrier according to one or more embodiments of the present invention;

Fig. 3 schematically shows two exemplary communication devices operating in different sub-bands in a system carrier according to one or more embodiments of the present invention;

Fig. 4 schematically shows an exemplary communication device switching from an operation sub-band to another sub-band in which reference signals for mobility measurement are transmitted according to one or more embodiments of the present invention;

Fig. 5 schematically illustrates an exemplary flow diagram for an access node configuring a device switching from an operation sub-band for mobility measurement in a wireless network according to one or more embodiments of the present invention;

Fig. 6 schematically illustrates another exemplary flow diagram for an access node configuring a device switching from an operation sub-band for mobility measurement in a wireless network according to one or more embodiments of the present invention;

Fig. 7 schematically illustrates a block diagram of a communication device according to one or more embodiments of the present invention; and

Fig. 8 schematically illustrates a block diagram of an access node according to one or more embodiments of the present invention.

Detailed Description of Embodiments

Embodiments herein will be described in detail hereinafter with reference to the accompanying drawings, in which embodiments are shown. These embodiments herein may, however, be embodied in many different

forms and should not be construed as being limited to the embodiments set forth herein. The elements of the drawings are not necessarily to scale relative to each other. Like numbers refer to like elements throughout.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" "comprising," "includes" and/or "including" when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meanings as commonly understood. It will be further understood that a term used herein should be interpreted as having a meaning consistent with its meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

The present disclosure is described below with reference to block diagrams and/or flowchart illustrations of methods, nodes, devices and/or computer program products according to the present embodiments. It is understood that blocks of the block diagrams and/or flowchart illustrations, and combinations of blocks in the block diagrams and/or flowchart illustrations, may be implemented by computer program instructions. These computer program instructions may be provided to a processor, controller or controlling unit of a general purpose computer, special purpose computer, and/or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer and/or other programmable data processing apparatus, create means for implementing the functions/acts specified in the block diagrams and/or flowchart block or blocks.

Accordingly, the present technology may be embodied in hardware

and/or in software (including firmware, resident software, micro-code, etc.). Furthermore, the present technology may take the form of a computer program product on a computer-usable or computer-readable storage medium having computer-usable or computer-readable program code embodied in the medium for use by or in connection with an instruction execution system. In the context of this document, a computer-usable or computer-readable medium may be any medium that may contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

Fig. 1 schematically illustrates an exemplary flow diagram for a communication device switching from an operation sub-band for mobility measurement in a wireless network according to one or more embodiments of the present invention. An operation sub-band for a communication device refers to the sub-band in which the communication is operating under a control of an access node. The communication device transmits data to, and receives data and control signalings from the access node in the operation sub-band for the communication device. For example, as shown in Fig. 4, if the communication device switches from the current operation sub-band, e.g., sub-band 2, to another sub-band, e.g., sub-band 1, the operation sub-band for the communication device changes from sub-band 2 to sub-band 1 accordingly.

In the present disclosure, communication devices also known as mobile terminals, wireless terminals and/or User Equipment (UE) are enabled to communicate wirelessly with an access node in a wireless network, sometimes also referred to as a cellular radio system. For instance, a communication device may be, but is not limited to: mobile phone, smart phone, sensor device, meter, vehicle, household appliance, medical appliance, media player, camera, or any type of consumer electronic, for instance, but not limited to, television, radio, lighting arrangement, tablet computer, laptop, or Personal Computer (PC). The communication device may be a portable, pocket-storable, hand-held,

computer-comprised, or vehicle-mounted mobile device, enabled to communicate voice and/or data, via a wireless or wired connection.

Referring to Fig. 2, there are a plurality of sub-bands for a system carrier in a wireless network. The reference signals for mobility measurement are transmitted from at least one of the plurality of communication devices, according to time and frequency properties of the specific reference signals employed in the system design. For example, the reference signals for mobility measurement could be at least one of Primary Synchronization Signals (PSS), Secondary Synchronization Signals (SSS), Extended Synchronization Signals (ESS), Mobility Reference Signals (MRS), and/or Channel State Information-Reference Signals (CSI-RS) in the 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) systems and next generation communication systems. As shown in Fig. 2, UE 1 is operating in its operation sub-band in which the reference signals for mobility measurement are transmitted, while UE 2 is operating in its operation sub-band in which no reference signals for mobility measurement are transmitted. The periodic cycle for the reference signal repetition is illustrated as T In Fig. 2, there is no overlap in the frequency domain for the operation sub-band for the UE 1 and the operation sub-band for the UE 2. There may exist more than one sub-band in which the reference signals for mobility measurement are transmitted. One preferable sub-band configuration may be an overlapping bandwidth of the sub-bands in which the reference signals for mobility measurement are transmitted is equal to the bandwidth occupied by the reference signals for mobility measurement, as shown in Fig. 3 for example. It is noted that with the teaching and guidance in this disclosure, a skilled in the art could design and contemplate different sub-band configurations, e.g., different portioning in the frequency domain for the sub-bands in a system carrier, according to specific reference signal properties and system requirements.

For a communication device operating in an operation sub-band without reference signals for mobility measurement transmitted therein, in

a measurement gap implementation, the communication device may stop transmitting and receiving data in its operation sub-band, measure the reference signals for mobility measurement and then return to its operation sub-band to continue its transmission, leading to an unavoidable service interruption. In this disclosure, for a communication device operating in an operation sub-band without reference signals for mobility measurement transmitted therein, if the signal quality of this communication device is lower than a preconfigured threshold, the communication device may switch to a sub-band in which the reference signals for mobility measurement are transmitted, and the communication device could measure the reference signals for mobility measurement from different cells in order to perform a mobility procedure, such as inter-cell handover for example. Meanwhile, a communication device with good signal quality can be switched from a sub-band in which the reference signals for mobility measurement are transmitted to another sub-band in which no reference signals for mobility measurement are transmitted, in order to reduce the load of the sub-bands in which reference signals for mobility measurement are transmitted. It is noted that the switch between a sub-band with the reference signals for mobility measurement transmitted therein and a sub-band without the reference signals for mobility measurement transmitted therein for a communication device could be triggered either by the communication device or the access node. In this way, the sub-bands in which a mobility measurement could be performed are dynamically shared between difference communication devices and a communication device can be continuously served during the mobility measurement, i.e., no measurement gap is required anymore. It is desirable that during the measurement in the newly switched-to sub-band in which the reference signals for mobility measurement are transmitted, the communication device may still monitor Downlink Control In formation (DCI) transmission and perform the data transmission and reception in the newly switched-to sub-band.

It will be appreciated for the person skilled in the art that the term

mobility management generally refers to radio resource management including time and frequency resource and/or serving cell reallocation for a communication device through mobility management procedures for the communication device, such as handover or cell reselection procedures for example. The term mobility measurement refers to a signal quality measurement in the mobility management procedures. It should be also noted that unless specified otherwise, the term mobility measurement and Radio Resource Management (RRM) measurement could be used interchangeably throughout this disclosure.

Returning to Fig. 1, in step 110, a communication device measures a signal quality for an operation sub-band of the communication device. In one example, as discussed above, the operation sub-band of the communication device may be a sub-band in which no reference signals for mobility measurement are transmitted. For this case, the communication device may measure the signal quality with respect to other reference signals transmitted in the operation sub-band of the communication, such as Cell-Specific References (CSR) or UE-Specific Reference Signals for example. In another example, the operation sub-band of the communication device may be a sub-band in which reference signals for mobility measurement are transmitted, and for this case, the communication device may measure the signal quality with respect to the reference signals for mobility measurement. It may also measure the signal quality with respect to other reference signals, such as CSR or UE-Specific Reference Signals. It is desirable for the person skilled in the art to employ different signal quality measurement mechanisms without departing from the teachings in this disclosure.

In step 120, the communication device compares the signal quality with a signal quality threshold. The signal quality threshold may be preconfigured by the network, or it can be updated periodically according to different system configurations. More specifically, if no reference signals for mobility measurement are transmitted in the operation sub-band of the communication device, the signal quality threshold may be a first

signal quality threshold. In such a circumstance, the communication device measures the signal quality of the operation sub-band and compares it with the first signal quality threshold to monitor the channel quality of the operation sub-band. If the signal quality is lower than the first signal quality threshold, it means the channel quality is so bad that a mobility procedure may be triggered for the communication device. On the other hand, if the reference signals for mobility measurement are transmitted in the operation sub-band of the communication device, the signal quality threshold may be a second signal quality threshold. In such a circumstance, the communication device measures the signal quality of the operation sub-band and compares it with the second signal quality threshold to monitor the channel quality. If the signal quality is higher than the second signal quality threshold, it means that the channel quality is so good and the communication device may be switched to a sub-band in which no reference signals for mobility measurement are transmitted, in order to reduce the load of the sub-bands in which the reference signals for mobility measurement are transmitted.

In step 130, the communication device determines a switch action according to the comparison of the signal quality with the signal quality threshold. As discussed above, the signal quality threshold could be either one of the first signal quality threshold and the second signal quality threshold, depending on whether there are reference signals for mobility measurement transmitted in the operation sub-band of the communication device. The switch action for a communication device refers to a switching decision for the communication devices from one operation sub-band to another sub-band. Referring to Fig. 4, it is assumed that signal quality of operation sub-band 2 for UE 1 is lower than the first signal quality threshold. In this case, a switch action for UE 1 corresponds to a switching decision from sub-band 2 to sub-band 1.

In step 140, the communication device switches from the operation sub-band according to the determined switch action. As aforementioned, according to one embodiment of the disclosure, the operation sub-band of

the communication device may be a sub-band in which the reference signals for mobility measurement are not transmitted, and the signal quality threshold is the first signal quality threshold. More specifically, in step 1410, the communication device switches to a sub-band in which the reference signals for mobility measurement are transmitted in response to the comparison result that the signal quality is lower than the first signal quality threshold. According to another embodiment of the disclosure, the operation sub-band of the communication device may be a sub-band in which the reference signals for mobility measurement are transmitted, and the signal quality threshold is the second signal quality threshold. In step 1420, the communication device may switch to a sub-band in which the reference signals for mobility measurement are not transmitted in response to the comparison result that the signal quality is higher than the second signal quality threshold.

Many different ways of executing the method are possible, as will be apparent to a person skilled in the art. For example, the order of the steps can be varied or some steps may be executed in parallel. Moreover, in between steps other method steps may be inserted. The inserted steps may represent refinements of the method such as described herein, or may be unrelated to the method. For example, steps may be executed, at least partially, in parallel. A given step may not have finished completely before a next step is started. Moreover, fewer than all the illustrated blocks may be required to implement an example methodology. Blocks may be combined or separated into multiple components. Furthermore, additional or alternative methodologies can employ additional, not illustrated blocks.

According to a further embodiment of the disclosure, after step 130, the communication device may report the determined switch action to the access node for a further decision made by the network side. The access node may take the load of different sub-bands or the service requirements for example into consideration and make a further switch decision for the communication device according to different system implementations and configurations. It is desirable for the skilled in the art to develop different

implementations according to different system requirements without departing from the spirit of this disclosure. It will be appreciated that different practical implementation strategies should not be construed as any limitation to the scope of this invention. It should be also appreciated that the signal quality could be Reference Signal Receiving Power (RSRP), Reference Signal Receiving Quality (RSRQ), Received Signal Strength Indication (RSSI), Signal to Noise Ratio (SNR), or Signal to Interference plus Noise Ratio (SINR), which can be chosen by one skilled in the art according to different system implementation and application scenarios.

Typically, an access node may serve or cover one or several cells of the wireless communication system. That is, the access node provides radio coverage in the cell(s) and communicates over an air interface with communication devices operating on radio frequencies within its range. The access node in some wireless communication systems may be also referred to as “eNB”, “eNodeB”, “NodeB”, “B node”, gNode B’ or ‘gNB’, for example, depending on the technology and terminology used. In the present disclosure, the access node may also be referred to as a Base Station (BS). The access node may be of different classes such as e.g. macro eNodeB, home eNodeB or pico base station, or relay node in heterogeneous or homogeneous networks, based on transmission power and thereby also cell size.

Fig. 5 schematically illustrates an exemplary flow diagram for an access node configuring a device switching from an operation sub-band for mobility measurement in a wireless network according to one or more embodiments of the present invention.

In step 510, the access node determines whether switch condition is satisfied for a communication device. The switch condition could be based on the radio quality of the communication device or load of the sub-band in which the reference signals for mobility measurement are transmitted, which will be discussed in detail as below.

According to one embodiment of the disclosure, in step 5120, the access node receives a measurement report from the communication device.

In step 5130, the access node determines a radio quality according to the measurement report from the communication device. For example, the radio quality may be determined as an average of a plurality of radio qualities received in one or more measurement reports from the communication device. In step 5140, the access node compares the determined radio quality with a radio quality threshold to determine whether a switch condition is satisfied for the communication device. According to another embodiment of the disclosure, in step 5110, the access node may configure the communication device to send the measurement report in response to a signal quality being lower than a configured signal quality threshold in order to reduce overhead of measurement reports from the communication device.

In step 520, the access node configures the communication device with a switch action in response to determining the switch condition is satisfied for the communication device. This configuration from the access node to the communication device may be transmitted via different signalings, such as a Radio Resource Control (RRC) signalling, Media Access Control (MAC) signalling (e.g. MAC control element (CE) signalling) in LTE or next generation communication systems. It should be also appreciated that the radio quality could be RSRP, RSRQ, RSSI, SNR or SINR, which can be chosen by one skilled in the art according to different system implementation and application scenarios.

According to one embodiment of the disclosure, in step 5210, the access node may configure the communication device with a switch action according to the comparison result of the radio quality with the radio quality threshold. According to another embodiment of the disclosure, an operation sub-band of the communication device is a sub-band in which the reference signals for mobility measurement are not transmitted, and the radio quality threshold is a first radio quality threshold. In step 52110, the access node may configure the communication device to switch to a sub-band in which the reference signals for mobility measurement are transmitted in response to the comparison result that the radio quality is

lower than the first radio quality threshold. According to another embodiment of the disclosure, an operation sub-band of the communication device is a sub-band in which the reference signals for mobility measurement are transmitted, and the radio quality threshold is a second radio quality threshold. In step 52120, the access node may configure the communication device to switch to a sub-band in which the reference signals for mobility measurement are not transmitted in response to the comparison result that the radio quality is higher than the second radio quality threshold. According to another embodiment of the disclosure, an operation sub-band of the communication device is a sub-band in which the reference signals for mobility measurement are not transmitted and in step 52130, the access node may configure the communication device to switch to a sub-band in which the reference signals for mobility measurement are transmitted periodically.

Fig. 6 schematically illustrates another exemplary flow diagram for an access node configuring a device to switch from an operation sub-band for mobility measurement in a wireless network according to one or more embodiments of the present invention.

In step 610, the access node determines whether a switch condition is satisfied for the communication device. According to one embodiment of the disclosure, in step 6110, the access node measures a load for a sub-band in which the reference signals for mobility measurement are transmitted. For example, the load could be measured based on the time and frequency resource utilization of the sub-band in which the reference signals for mobility measurement are transmitted. In step 6120, the access node compares the load with a load threshold to determine whether the sub-band in which the reference signals for mobility measurement are transmitted is overloaded.

In step 620, the access node configures the communication device with a switch action in response to determining the switch condition is satisfied for the communication device. According to one embodiment of the disclosure, in step 6210, the access node may select one or more

communication devices operating in the sub-band in which the reference signals for mobility measurement are transmitted. For one example, the selection of the one or more communication device may be performed randomly or in round-robin fashion. For another example, the selection of the one or more communication devices may be performed according to the service priority or requirement of the communication device. For a further example, the communication devices with a low priority service may be selected first. It is noted that the person skilled in the art could employ different selection mechanisms with the teaching and suggestion in this disclosure. In step 6220, the access node may configure the one or more communication devices to switch to a sub-band in which the reference signals for mobility measurement are not transmitted so that the load of the sub-band in which the reference signals for mobility measurement are transmitted becomes lower than another load threshold. According to another embodiment of the disclosure, the access node may configure the communication device to switch to a sub-band in which the reference signals for mobility measurement are transmitted periodically. As discussed above, the service for the communication device is continuously provided, and meanwhile the communication device may perform mobility measurement in the sub-band with reference signals for mobility measurement transmitted therein to determine if there is a neighbor cell good enough for handover.

According to a further embodiment of the disclosure, when an operation sub-band of the communication device is switched to, some configurations can be stored for the communication device in case the communication device is switched back, in order to save signaling overhead. The following configurations can be reused when the communication device switches back to the previous operation sub-band: Downlink Control Information (DCI) search space, CSI-RS configurations and CSI report configurations, numerology and/or Transmission Time Interval (TTI) duration configurations for example. When the communication device is switched back to the previous operation sub-band,

the communication device may fetch these configurations from its local memory and applies these configurations. Some configurations may remain unchanged during operation sub-band switching: Discontinuous Reception (DRX) timer values, power control parameters and CSI report configuration.

Fig. 7 schematically illustrates a block diagram of a communication device according to one or more embodiments of the present invention.

The communication device may for example correspond to the communication device described in connection with Fig. 1. The communication device comprises a memory storing instructions and a processing system configured to execute the instructions performing the steps of the method illustrated in connection with Fig. 1. For example, the processing system may include one or more microprocessors or microcontrollers, as well as other digital hardware, which may include Digital Signal Processors (DSP), special-purpose digital logic, and the like. The processors may be configured to execute program code stored in memory. Instructions stored in memory includes program codes for executing one or more telecommunications and/or data communications protocols as well as program codes for carrying out one or more of the techniques described herein, in several embodiments. For example, the memory may include a Read Only Memory (ROM), e.g., a flash ROM, a Random Access Memory (RAM), e.g., a Dynamic RAM (DRAM) or Static RAM (SRAM), a mass storage, e.g., a hard disk or solid state disk, or the like. The memory has stored thereon suitably configured program code to be executed by the processing system so as to implement the above-described functionalities of the communication device. In particular, the memory may include various program code modules for causing the communication device to perform processes as described above, e.g., corresponding to the method steps of Fig. 1. The communication device may also comprise at least one interface (not shown) for communicating with the access node, e.g. a wireless interface. The interface could be coupled to the processing system. Information and data as described above

in connection with the methods may be sent via the interface.

Fig. 8 schematically illustrates a block diagram of an access node according to one or more embodiments of the present invention.

The access node may for example correspond to the access node described in connection with Figs. 5-6. The access node comprises a memory storing instructions and a processing system configured to execute the instructions performing the steps of the method illustrated in connection with Figs. 5-6. For example, the processing system may include one or more microprocessors or microcontrollers, as well as other digital hardware, which may include DSP, special-purpose digital logic, and the like. The processors may be configured to execute program code stored in memory. Instructions stored in memory includes program codes for executing one or more telecommunications and/or data communications protocols as well as program codes for carrying out one or more of the techniques described herein, in several embodiments. For example, the memory may include a ROM, e.g., a flash ROM, a RAM, e.g., a DRAM or SRAM, a mass storage, e.g., a hard disk or solid state disk, or the like. The memory has stored thereon suitably configured program code to be executed by the processing system so as to implement the above-described functionalities of the access node. In particular, the memory may include various program code modules for causing the access node to perform processes as described above, e.g., corresponding to the method steps of any one of Figs. 5-6. The access node may also comprise at least one interface (not shown) for communicating with the communication device, e.g. a wireless interface, and/or for communicating with the neighboring access nodes, e.g. a wired or wireless interface. The interface could be coupled to the processing system. Information and data as described above in connection with the methods may be sent via the interface.

The present disclosure may also be embodied in the computer program product which comprises all features capable of implementing the method as depicted herein and may implement the method when loaded to

the computer system. A set of software modules may correspond to a set of respective steps or actions in any method described in conjunction with Figs. 1, 5 or 6, and it is appreciated for the person skilled in the art that the aforementioned modules could be implemented via Programmable Logic Device (PLD), Field Programmable Gate Array (FPGA), Application Specific Integrated Circuit (ASIC), and other implement mechanisms as software products, application specific firmware, hardware products and a combination thereof.

In general, the various exemplary embodiments may be implemented in hardware or special purpose circuits, software, logical or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the disclosure is not limited thereto. While various aspects of the exemplary embodiments of this disclosure may be illustrated and described as block and signaling diagrams, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logical, general purpose hardware or controller or other computing devices, or some combination thereof.

The present disclosure has been specifically illustrated and explained with reference to the preferred embodiments. The skilled in the art should understand various changes, variation, or modifications thereto in form and details may be made without departing from the spirit and scope of the present disclosure.

CLAIMS

1. A method for a communication device in a wireless network, wherein a system carrier of the wireless network comprises a plurality of sub-bands, and reference signals for mobility measurement are transmitted in at least one of the plurality of sub-bands, the method comprising:

- measuring (110) a signal quality for an operation sub-band;

- comparing (120) the signal quality with a signal quality threshold;

- determining (130) a switch action according to the comparison of the signal quality with the signal quality threshold; and

- switching (140) from the operation sub-band according to the determined switch action.

2. The method according to Claim 1, wherein the operation sub-band of the communication device is a sub-band in which the reference signals are not transmitted, the signal quality threshold is a first signal quality threshold, and the switching from the operation sub-band according to the determined switch action further comprises:

- switching (1410) to a sub-band in which the reference signals are transmitted in response to the comparison result that the signal quality is lower than the first signal quality threshold.

3. The method according to Claim 1, wherein the operation sub-band of the communication device is a sub-band in which the reference signals are transmitted, the signal quality threshold is a second signal quality threshold, and the switching from the operation sub-band according to the determined switch action further comprises:

- switching (1420) to a sub-band in which the reference signals are not transmitted in response to the comparison result that the signal quality is higher than the second signal quality threshold.

4. A method for an access node in a wireless network, wherein a system carrier of the wireless network comprises a plurality of sub-bands, and reference signals for mobility measurement is transmitted in at least one of the plurality of sub-bands, the method comprising:

- determining (510; 610) whether a switch condition is satisfied for a communication device; and

- configuring (520; 620) the communication device with a switch action in response to determining the switch condition being satisfied for the communication device.

5. The method according to Claim 4, wherein the step of determining whether a switch condition is satisfied further comprises steps of:

- receiving (5120) a measurement report from the communication device;

- determining (5130) a radio quality according to the measurement report; and

- comparing (5140) the radio quality with a radio quality threshold; and the step of configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device further comprising a step of:

- configuring (5210) the communication device with a switch action according to the comparison result of the ratio quality with the radio quality threshold.

6. The method according to Claim 5, wherein the step of determining whether a switch condition is satisfied for a communication device further comprises a step of:

- configuring (5110) the communication device to send the measurement report in response to a signal quality of the communication device being lower than a configured signal quality threshold.

7. The method according to Claim 5, wherein an operation sub-band of the communication device is a sub-band in which the reference signals are not transmitted, the radio quality threshold is a first radio quality threshold, and the step of configuring the communication device with a switch action according to the comparison result of the ratio quality with the radio quality threshold further comprises a step of:

- configuring (52110) the communication device to switch to a sub-band in which the reference signals are transmitted in response to the

comparison result that the radio quality is lower than the first radio quality threshold.

8. The method according to Claim 5, wherein an operation sub-band of the communication device is a sub-band in which the reference signals are transmitted, the radio quality threshold is a second radio quality threshold, and the step of configuring the communication device with a switch action according to the comparison result of the ratio quality with the radio quality threshold further comprises a step of:

- configuring (52120) the communication device to switch to a sub-band in which the reference signals are not transmitted in response to the comparison result that the radio quality is higher than the second radio quality threshold.

9. The method according to any one of Claims 4 to 8, wherein the step of determining whether a switch condition is satisfied further comprises steps of:

- measuring (6110) a load for a sub-band in which the reference signals are transmitted; and

- comparing (6120) the load with a load threshold; and the step of configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device further comprising steps of:

- selecting (6210) one or more communication devices operating in the sub-band in which the reference signals are transmitted; and

- configuring (6220) the one or more communication devices to switch to a sub-band in which the reference signals are not transmitted.

10. The method according to any one of Claims 4 to 9, wherein an operation sub-band of the communication device is a sub-band in which the reference signals are not transmitted and the step of configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device further comprises a step of:

- configuring (52130; 6230) the communication device to switch to a

sub-band in which the reference signals are transmitted periodically.

11. A communication device (700) in a wireless network, the communication device comprising:

- a memory (720) storing instructions; and

- a processing system (710) configured to execute the instructions performing the steps of the method according to any one of the Claims 1-3.

12. A computer readable storage medium, which store instructions which, when run on a processing system of a communication device for a wireless network, cause the communication device to perform the steps of the method according to any one of the Claims 1-3.

13. An access node (800) in a wireless network, the access node comprising:

- a memory (820) storing instructions; and

- a processing system (810) configured to execute the instructions performing the steps of the method according to any one of the Claims 4-10.

14. A computer readable storage medium, which store instructions which, when run on a processing system of an access node for a wireless network, cause the access node to perform the steps of the method according to any one of the Claims 4-10.

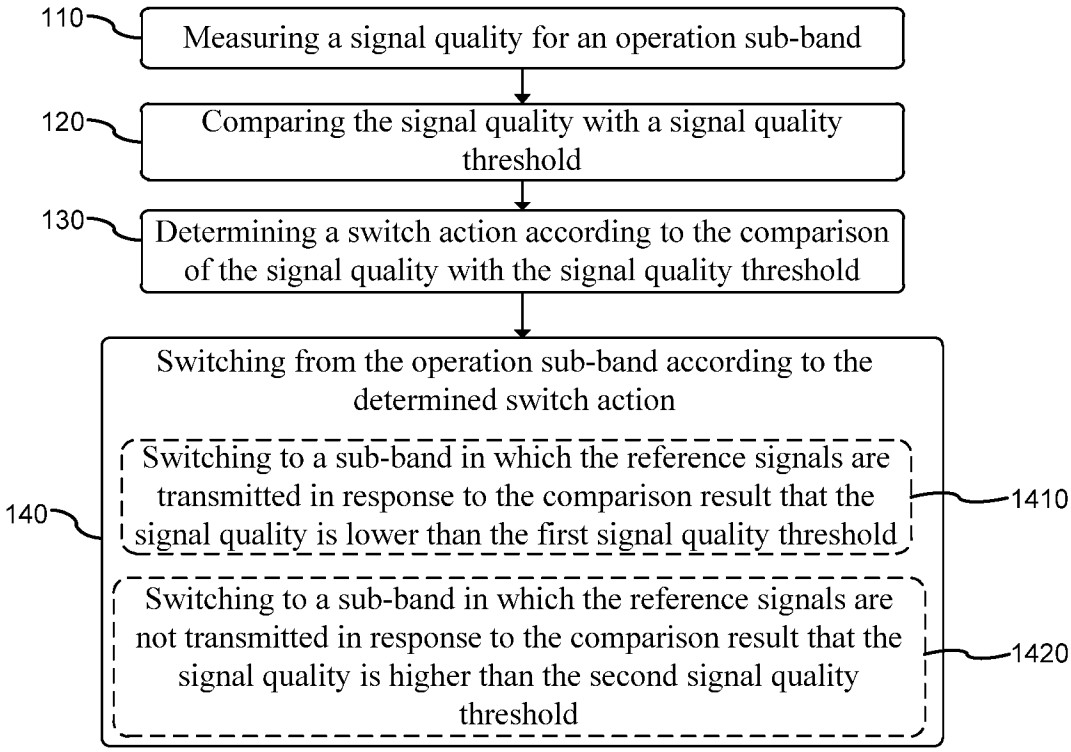
110
Measuring a signal quality for an operation sub-band
120
Comparing the signal quality with a signal quality threshold
130
Determining a switch action according to the comparison of the signal quality with the signal quality threshold
Switching from the operation sub-band according to the determined switch action
140
Switching to a sub-band in which the reference signals are transmitted in response to the comparison result that the signal quality is lower than the first signal quality threshold
1410
Switching to a sub-band in which the reference signals are not transmitted in response to the comparison result that the signal quality is higher than the second signal quality threshold
1420

Fig.1

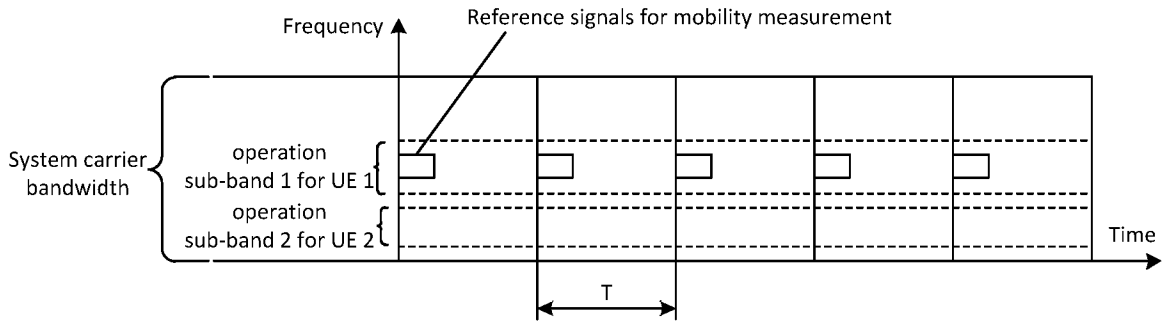
Frequency
Reference signals for mobility measurement
System carrier bandwidth
operation sub-band 1 for UE 1
operation sub-band 2 for UE 2
Time
T

Fig.2

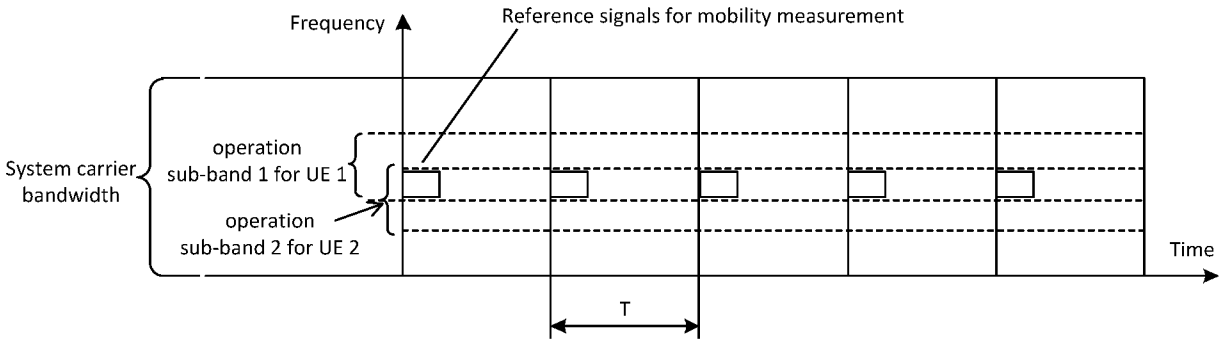
Frequency
Reference signals for mobility measurement
System carrier bandwidth
operation sub-band 1 for UE 1
operation sub-band 2 for UE 2
Time
T

Fig.3

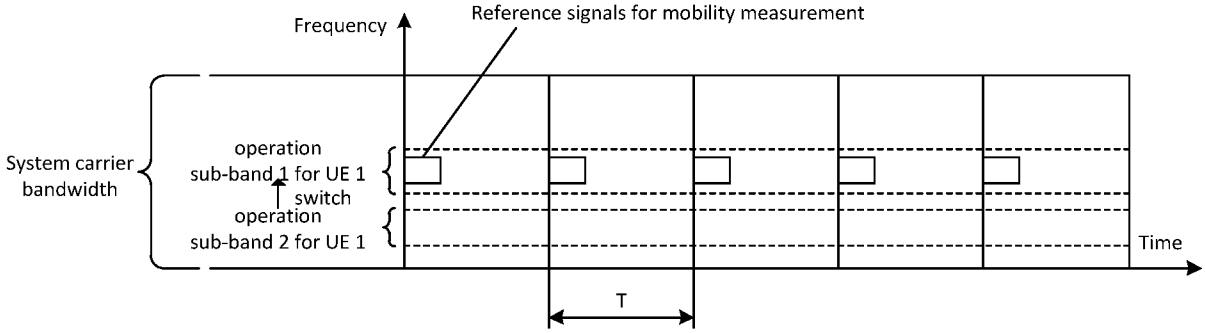
Frequency
Reference signals for mobility measurement
System carrier bandwidth
operation sub-band 1 for UE 1
switch
operation sub-band 2 for UE 1
Time
T

Fig.4

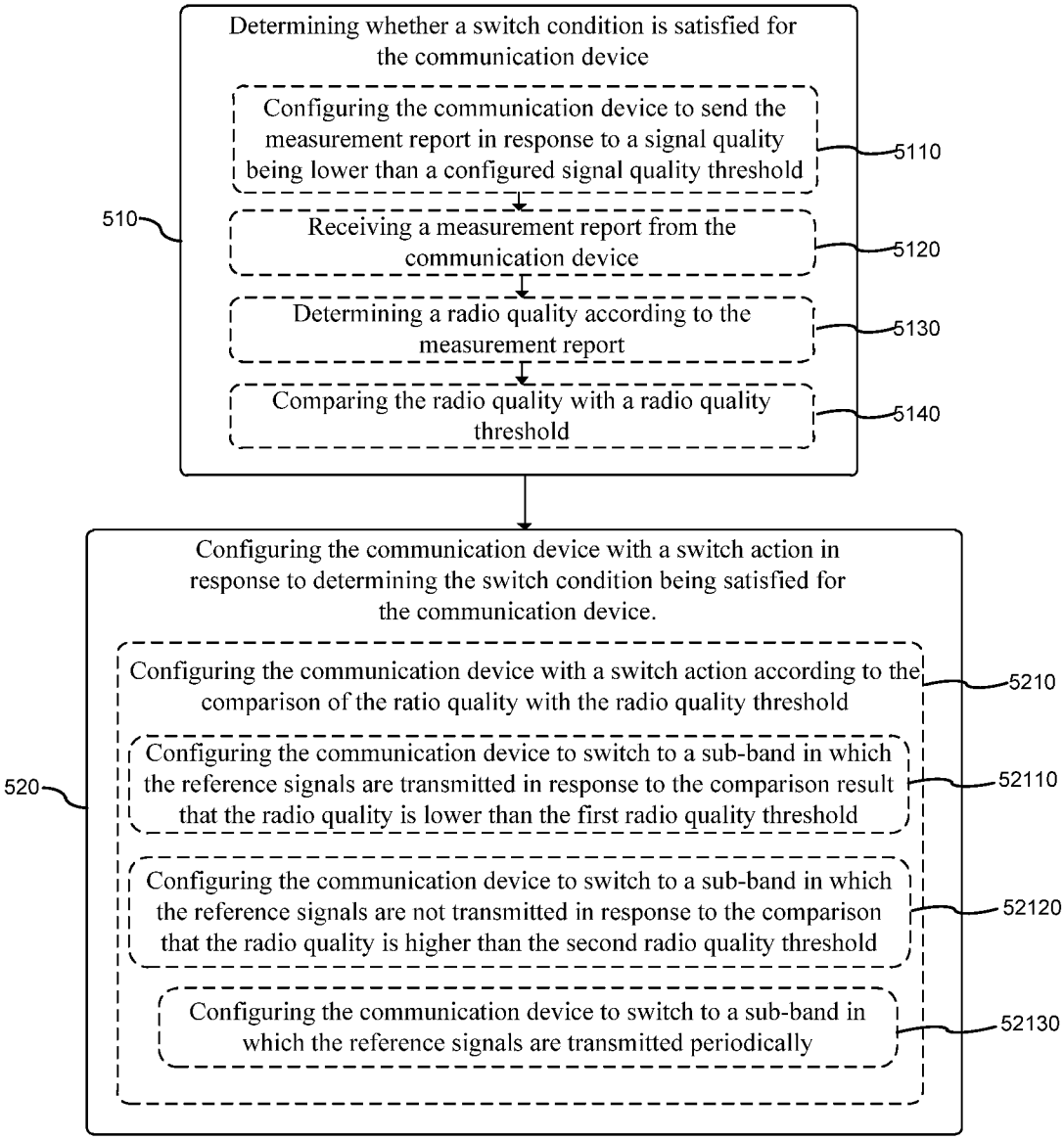
Determining whether a switch condition is satisfied for the communication device
Configuring the communication device to send the measurement report in response to a signal quality being lower than a configured signal quality threshold
5110
510
Receiving a measurement report from the communication device
5120
Determining a radio quality according to the measurement report
5130
Comparing the radio quality with a radio quality threshold
5140
Configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device.
Configuring the communication device with a switch action according to the comparison of the ratio quality with the radio quality threshold
5210
520
Configuring the communication device to switch to a sub-band in which the reference signals are transmitted in response to the comparison result that the radio quality is lower than the first radio quality threshold
52110
Configuring the communication device to switch to a sub-band in which the reference signals are not transmitted in response to the comparison that the radio quality is higher than the second radio quality threshold
52120
Configuring the communication device to switch to a sub-band in which the reference signals are transmitted periodically
52130

Fig.5

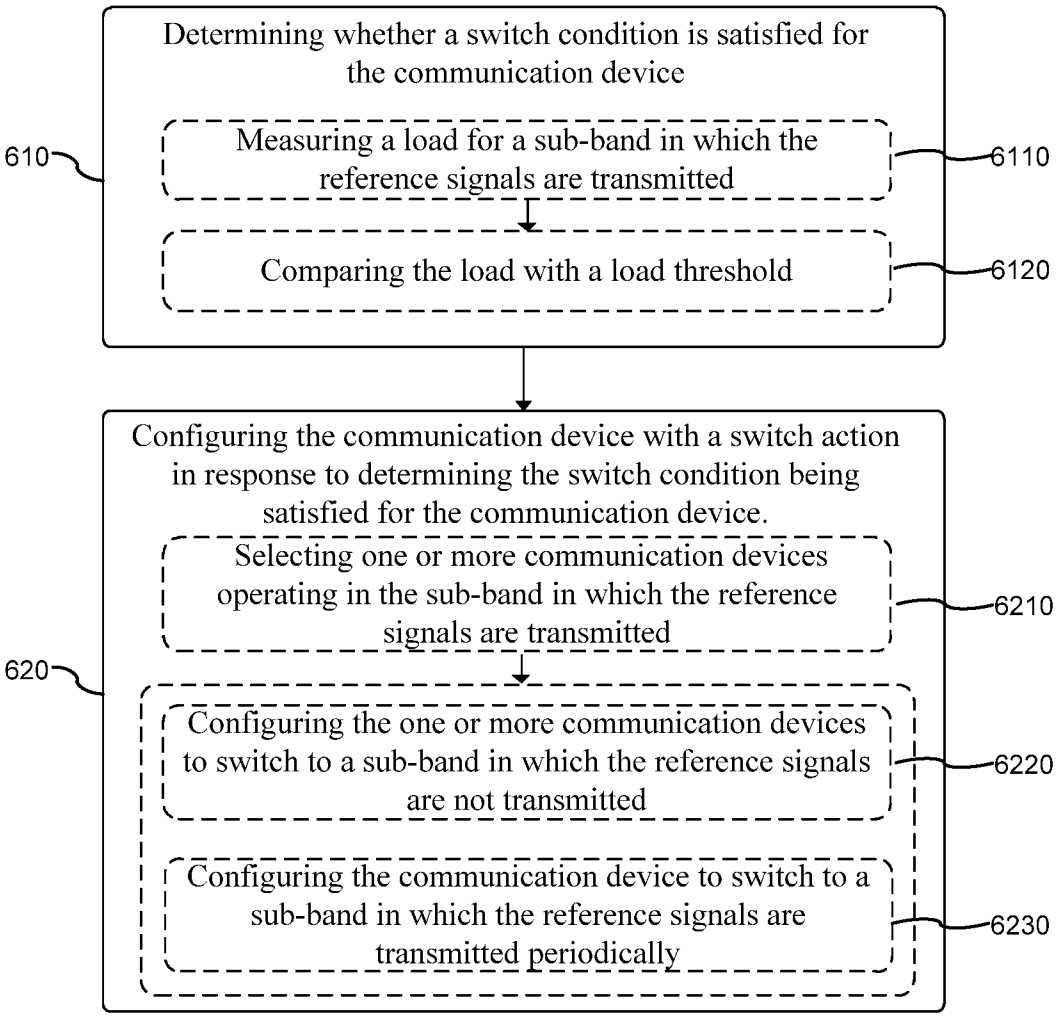
Determining whether a switch condition is satisfied for the communication device
610
Measuring a load for a sub-band in which the reference signals are transmitted
6110
Comparing the load with a load threshold
6120
Configuring the communication device with a switch action in response to determining the switch condition being satisfied for the communication device.
620
Selecting one or more communication devices operating in the sub-band in which the reference signals are transmitted
6210
Configuring the one or more communication devices to switch to a sub-band in which the reference signals are not transmitted
6220
Configuring the communication device to switch to a sub-band in which the reference signals are transmitted periodically
6230

Fig.6

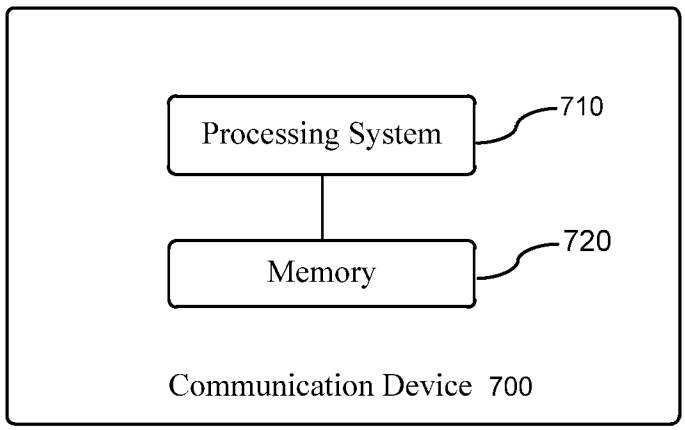
Processing System
710
Memory
720
Communication Device 700

Fig.7

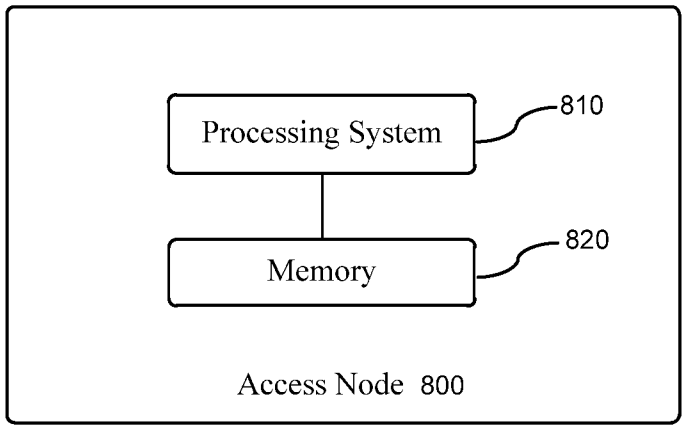

Fig.8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/111547

A. CLASSIFICATION OF SUBJECT MATTER

H04W 36/30(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)

H04W; H04L; H04B

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: mobility, measur+, sub, handover, reference, gap, sub-band?, operation, subband?, band?, threshold, PSS, SSS, switch, LTE, quality

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103428748 A (HUAWEI TECHNOLOGIES CO., LTD.) 04 December 2013 (2013-12-04) abstract, description, paragraphs [0032] to [0067]	1, 4-6, 11-14
A	CN 101449500 A (NTT DOCOMO INC.) 03 June 2009 (2009-06-03) the whole document	1-14
A	CN 102577511 A (ALCATEL LUCENT) 11 July 2012 (2012-07-11) the whole document	1-14
A	CN 1930800 A (SAMSUNG ELECTRONICS CO., LTD.) 14 March 2007 (2007-03-14) the whole document	1-14
A	US 2011255436 A1 (XU, JIAN ET AL.) 20 October 2011 (2011-10-20) the whole document	1-14

☐ 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
26 January 2018	**14 February 2018**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**YANG,Fengxin**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)53961744**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/111547

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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CN	101449500	A	03 June 2009	JP	2007258845	A	04 October 2007
				KR	20090008221	A	21 January 2009
				WO	2007111185	A1	04 October 2007
				TW	200746691	A	16 December 2007
				US	2010003979	A1	07 January 2010
				EP	1998577	A1	03 December 2008
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				US	2012207133	A1	16 August 2012
				JP	2013502119	A	17 January 2013
				WO	2011018173	A1	17 February 2011
				EP	2285159	A1	16 February 2011
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				US	2005201327	A1	15 September 2005
				KR	20060044335	A	16 May 2006
				WO	2005088872	A1	22 September 2005
				EP	1575319	A2	14 September 2005
US	2011255436	A1	20 October 2011	WO	2011004947	A1	13 January 2011
				US	2012225753	A1	06 September 2012