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SCAN REDUCTION

Benjamin Wutt

Momo Shen

Qin Zhang

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ABSTRACT

A computing device (e.g., a mobile phone, a tablet computer, a laptop computer, a wearable device, etc.) may execute a scan reduction algorithm by skipping frequencies refarmed to radio access technology (RAT) that the computing device cannot camp on (hereinafter referred to as an "unsuitable RAT") during frequency band scan. Per the scan reduction algorithm, the computing device may check (e.g., when performing an initial cell selection procedure) whether a candidate frequency range from a candidate band set is occupied by an unsuitable RAT by querying an occupied frequency repository. If the query results indicate that the candidate frequency range is not occupied, the computing device may search for a suitable cell. If the query results indicate that the candidate frequency range is occupied, the computing device may skip that frequency range when performing the frequency band scan, potentially saving time.

DESCRIPTION

FIG. 1 below is a conceptual diagram illustrating a system 100 including a computing device 102 (sometimes referred to as user equipment (UE)) configured to communicate with a wireless network 104 ("network 104") via at least one of cells 106A-106N (collectively, "cells 106"). Cells 106 may be configured to transmit frequency blocks containing information for use by computing device 102. Each of cells 106 may represent a geographical area covered by a frequency emitted by a base station in network 104.

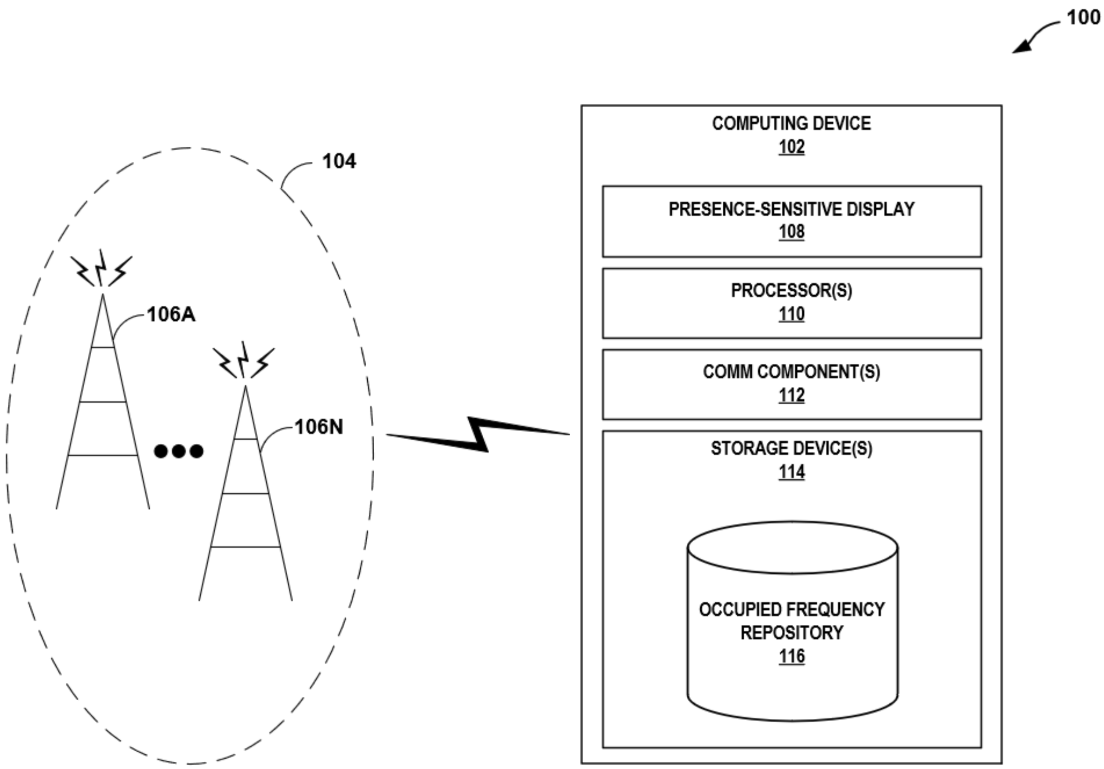

FIG. 1

In the example of FIG. 1, computing device 102 represents an individual mobile computing device. Examples of computing device 102 include a mobile phone, a tablet computer, a laptop computer, a wearable device (e.g., a computerized watch, computerized eyewear, etc.), a personal digital assistant (PDA), a gaming system, a media player, an e-book reader, a mobile television platform, an automobile navigation or infotainment system, or any other type of mobile computing device configured in accordance with techniques of this disclosure. As shown in FIG. 1, computing device 102 includes a presence-sensitive display 108, one or more processors 110, one or more communication components 112 ("COMM components 112"), and one or more storage devices 114. Storage devices 114 may include an occupied frequency repository 116.

Presence-sensitive display 108 of computing device 102 may be a presence-sensitive display that functions as an input device and as an output device. For example, presence-sensitive display 108 may function as an input device using a presence-sensitive input component, such as a resistive touchscreen, a surface acoustic wave touchscreen, a capacitive touchscreen, a projective capacitance touchscreen, a pressure sensitive screen, an acoustic pulse recognition touchscreen, or another presence-sensitive display technology. Additionally, presence-sensitive display 108 may function as an output (e.g., display) device using any of one or more display components, such as a liquid crystal display (LCD), dot matrix display, light emitting diode (LED) display, microLED display, organic light-emitting diode (OLED) display, e-ink, active-matrix organic light-emitting diode (AMOLED) display, or similar monochrome or color display capable of outputting visible information to a user of computing device 102.

Processors 110 may implement functionality and/or execute instructions associated with computing device 102. Examples of processors 110 may include one or more of an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), an application processor, a display controller, an auxiliary processor, a central processing unit (CPU), a graphics processing unit (GPU), one or more sensor hubs, and any other hardware configure to function as a processor, a processing unit, or a processing device.

Computing device 102 may include COMM components 112. COMM components 112 may receive and transmit various types of information over a network, such as a cellular radio, a third-generation (3G) radio, a fourth-generation (4G) radio, a fifth-generation (5G) radio, a Bluetooth® radio (or any other personal area network (PAN) radio), a near-field communication (NFC) radio, a WiFi® radio (or any other wireless local area network (WLAN) radio), and/or the like. Computing device 102 may communicate with network 104 via COMM components 112. For example, computing device 102 may transmit wireless signals (containing, e.g., voice traffic, data traffic, control signals, etc.) to and receive wireless signals from cells 106 of network 104 104 via COMM components 112.

Storage devices 114 may include one or more computer-readable storage media. For example, storage devices 114 may be configured for long-term, as well as short-term storage of information, such as instructions, data, or other information used by computing device 102. In some examples, storage devices 114 may include non-volatile storage elements. Examples of such non-volatile storage elements include magnetic hard discs, optical discs, solid state discs, and/or the like. In other examples, in place of, or in addition to the non-volatile storage elements, storage devices 114 may include one or more so-called “temporary” memory devices, meaning that a primary purpose of these devices may not be long-term data storage. For example, the devices may comprise volatile memory devices, meaning that the devices may not maintain stored contents when the devices are not receiving power. Examples of volatile memory devices include random-access memories (RAM), dynamic random-access memories (DRAM), static random-access memories (SRAM), etc.

In general, computing device 102 may be surrounded by a multitude of cells 106 of network 104 such that computing device 102 may need to perform an initial cell selection procedure to select a suitable cell to camp on. As used herein, ‘camp on’ may refer to a state in which computing device 102 stays on a cell and is ready to initiate a potential dedicated service or to receive an ongoing broadcast service. In some examples, computing device 102 may perform a frequency band scan by power scanning for a candidate frequency band or range and then fine scanning to select a suitable cell. For instance, computing device 102 may power scan each of the frequency bands by measuring the corresponding received signal strength indicator

(RSSI) (i.e., a measurement of the power present in a received radio signal) and then fine scan the frequency bands with suitable RSSIs to select a suitable cell to camp on.

While in some circumstances performing a power scan may make frequency band scan more efficient, the power scan may also mislead computing device 102 into determining that a suitable cell exists for a candidate frequency band when in reality no suitable cell exists. This issue can occur, for example, when a frequency band or range that was initially allocated to a legacy radio access technology (RAT), such as 2G or 3G cells, has been refarmed to a high RAT, such as Long-Term Evolution (LTE) cells, that computing device 102 cannot camp on (e.g., because computing device 102 is a Universal Mobile Telecommunications System (UMTS) device).

In this example, the high RAT cells may emit radio signals that become a source of RSSI for a frequency band. As a result, a power scan by computing device 102 may mislead computing device 102 into determining that a candidate frequency band has a suitable RSSI (that in turn triggers a fine scan) even if there were no suitable cells contributing to the RSSI for the candidate frequency band. This problem may be exacerbated by the fact that a bandwidth of an unsuitable RAT may be wider than the bandwidth of a current RAT (e.g., a LTE cell may have a bandwidth of 20 MHz and a 3G cell may have a bandwidth of 5 MHz), meaning that computing device 102 may be misled by the same unsuitable RAT multiple times when scanning for a suitable RAT to camp on.

In accordance with techniques of this disclosure, computing device 102 may execute a scan reduction algorithm by skipping frequencies refarmed to unsuitable RAT during frequency band scan. Per the scan reduction algorithm, computing device 102 may check (e.g., when performing an initial cell selection procedure) whether a candidate frequency range from a candidate band set is occupied by an unsuitable RAT by querying occupied frequency repository 116. If the query results indicate that the candidate frequency range is occupied, computing device 102 may skip that frequency range when performing the frequency band scan, potentially saving time. Computing device 102 may repeat this process for every candidate frequency range until computing device 102 camps on a suitable cell or no unoccupied frequency remains.

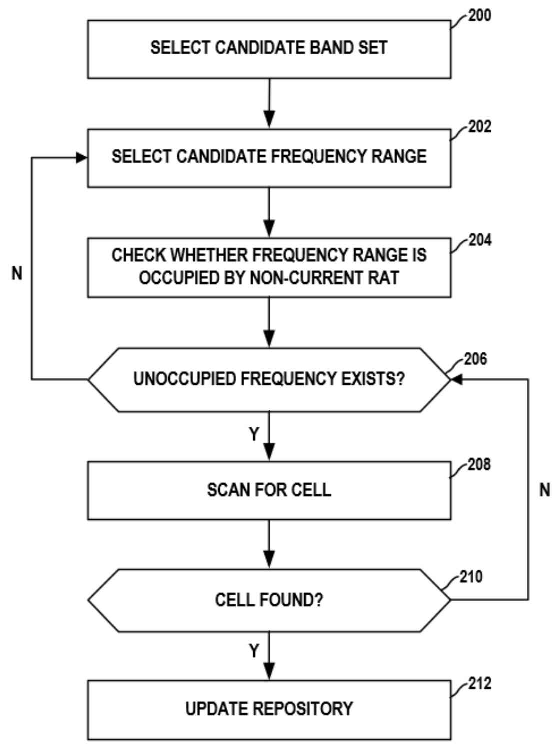

FIG. 2

FIG. 2 above is a flow diagram illustrating an example algorithm for scan reduction in accordance with techniques of this disclosure. As shown in FIG. 2, computing device 102 may select a candidate band set (200). Computing device 102 may select the candidate band set in response to an initial cell selection procedure being triggered (e.g., for power on cell selection, idle/connected out of service (OOS), leaving connected to idle, etc.). In general, computing device 102 may select the candidate band set based on the frequency bands supported by computing device 102 and information from telecommunications carriers. In some examples, computing device 102 may filter the candidate band set based on the information from the telecommunications carriers.

Computing device 102 may select a candidate frequency range within the candidate band set (202). Computing device 102 may check whether the candidate frequency range is occupied by an unsuitable RAT by querying occupied frequency repository 116 (204). In some examples, computing device 102 may query occupied frequency repository 116 with parameters such as the candidate frequency range, the RAT, a selected public land mobile network (PLMN), etc. If the query results from occupied frequency repository 116 indicate that the candidate frequency range is occupied (Y of 206), computing device 102 may skip that frequency range when performing the frequency band scan and select another candidate frequency range (202). On the other hand, if the query results from occupied frequency repository 116 indicate that the candidate frequency range is not occupied (N of 206), computing device 102 may fine scan for a suitable cell (208).

When performing a fine scan for a suitable cell, computing device 102 may or may not find a suitable cell in the unoccupied candidate frequency range. If computing device 102 finds a suitable cell in the unoccupied candidate frequency range (Y of 210), computing device 102 may update occupied frequency repository 116 accordingly (212). For example, computing device 102 may update occupied frequency repository 116 by storing information about the unoccupied candidate frequency range, the corresponding RAT, the PLMN, the timestamp for finding the suitable cell, etc., in occupied frequency repository 116. In this way, computing device 102 may dynamically maintain occupied frequency repository 116 (e.g., to account for any changes to cells 106). However, if computing device 102 fails to find a suitable cell in the unoccupied candidate frequency range (e.g., because a suitable cell in the unoccupied candidate frequency range does not exist) (N of 210), computing device 102 may select another candidate frequency range (202). In this way, computing device 102 may execute the algorithm for scan reduction for every candidate frequency range until computing device 102 camps on a suitable cell or no unoccupied frequency remains.

One or more advantages of the techniques may include decreasing scan time, thereby potentially making the initial cell selection procedure faster. Additionally, skipping frequencies in accordance with techniques of this disclosure may decrease power consumption without harming performance of computing device 102.

It is noted that the techniques of this disclosure may be combined with any other suitable technique or combination of techniques. As one example, the techniques of this disclosure may be combined with the techniques described in U.S. Patent Application Publication No. 2020/0314861A1. In another example, the techniques of this disclosure may be combined with the techniques described in U.S. Patent Application Publication No. 2016/0309399A1. In yet another example, the techniques of this disclosure may be combined with the techniques described in U.S. Patent Application Publication No. 2009/0042566A1. In yet another example, the techniques of this disclosure may be combined with the techniques described in U.S. Patent Application Publication No. 2010/0197301A1.