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LOW-POWER DEVICE OPERATION

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ABSTRACT

An electronic device sleep mode system places an Internet connected electronic device in a low-power "sleep" mode. The system identifies a battery level of the Internet connected electronic device. When the system determines that the battery level has reached a predetermined low battery threshold, the system wirelessly transmits a notification indicating the low battery level to a user of the Internet connected electronic device. After transmitting the notification, the system places the device in a low-power sleep mode. In the low-power sleep mode, the system switches off all wireless connection radios of the device such as WiFi, 3G, etc. The system also stops any active background operations such as: suspending downloads, suspending device upgrade activity. The system also suspends activities that might demand high processing power.

PROBLEM STATEMENT

A lot of Internet connected electronic devices such as a WiFi connected thermostat, Internet connected lighting system, smart lock, etc. are battery powered. An Internet connected smart lock, installed at a user's home may perform a door unlock function after detecting a digital key, such as a user's scanned fingerprints. In other embodiments, the digital key may be an application installed on user's electronic device, such as a smartphone. The smart lock may wirelessly detect the presence of user's smartphone in its vicinity and then transition from a locked state to unlocked state.

If a battery of a smart lock dies out, however, it would be unable to scan for a user's fingerprints or wirelessly detect a user's smartphone and thus not automatically unlock, which may cause inconvenience for its user. For example, a smart electronic door lock may run out of

battery when its user is away from home. As a result, the user may get locked out of his home because the door lock becomes unoperational due to insufficient battery power. The user may need to buy a replacement battery immediately in order to operate the door lock again. This can be a frustrating experience for the user. There is an opportunity to reduce this type of inconvenience and frustration to the user.

DETAILED DESCRIPTION

The systems and techniques described in this disclosure relate to a sleep mode system that places an Internet connected electronic device in a sleep mode when a battery level of the Internet connected electronic device reaches a predetermined threshold. The system can be implemented for use in an Internet, an intranet, or in a client and server environment. The client device with a user can be any electronic device such as a mobile device, a smartphone, a tablet, a handheld electronic device, a wearable device, etc. The Internet connected electronic device can be a physical hardware like a door lock to a room or automobile, an electronic safe lock, any other physical electronic locking appliance. The user's client device and the Internet connected electronic device, both are connected to a system server

Fig. 1 illustrates an example method 100 for running an Internet connected electronic device in a sleep mode when a battery level of the Internet connected electronic device reaches a predetermined low battery threshold. The method can be performed by the Internet connected electronic device.

The system identifies 102 a battery level of the Internet connected electronic device. The Internet connected electronic device can be a thermostat, automatic door lock, oven, etc. The Internet connected device may be equipped with one or more batteries, such as lithium-ion, lithium air, fuel cell,, etc. The system may periodically check the battery level of the device, e.g.,

after every 10 seconds. In an embodiment, the electronic device may display the battery level at a display screen associated with the device.

The system determines 104 whether the device battery level has reached a predetermined low battery threshold level. The predetermined threshold level can be set by a manufacturer, a system administrator, or a user of the Internet connected electronic device. The user may manually set the threshold battery level according to a personal preference. The user may set the predetermined threshold level by accessing a settings menu available on user's personal device connected to the Internet connected electronic device or a user interface (UI) associated with the Internet connected electronic device. The predetermined low battery threshold level signifies a battery level below which the Internet connected electronic device may run out of battery in a short span of time. In an example, the threshold battery level of the Internet connected electronic device may be set at 10 % of the overall device battery capacity.

In an example, the system may compare the identified battery level with the predetermined threshold level to determine 104 that the identified battery level is same as or below the predetermined threshold level. If the battery level has not reached the threshold level, the system waits 103 for a predetermined waiting period such as 10 seconds and then returns to identify 102 the battery level of the Internet connected device. Like the threshold setting, the waiting period may be set or adjusted by a manufacturer, a system administrator, or the user of the Internet connected electronic device. If the battery level is same or below the threshold level, the system proceeds to step 106 as shown in Fig. 1.

The system transmits 106 a notification to the user of the Internet connected device indicating the battery level. The notification can be delivered on a user's personal electronic device, e.g., a smartphone, tablet, mobile phone, laptop, desktop, etc. The user can register their

personal device with the system on which they would prefer to receive battery notifications related to their Internet connected home electronic device. The notification may include information such as name of the Internet connected electronic device whose battery is below the predetermined battery level, an indicator of the current battery level, estimated remaining time before the battery drain renders the electronic device inoperable, etc.

The system places 108 the Internet connected device in a low power sleep mode. In a sleep mode, the Internet connected device suspends the device operations and runs a bare minimum functionality in a low power state. For example, the system switches off all active radios on board the Internet connected electronic device, e.g., 3G radio, WiFi radio, etc. and dims its information display screen (e.g. LCD) to operate it at minimum level. The system may also stop any active background operations such as: suspending downloads, suspending device upgrade activity. In the low power sleep mode, the system may suspend activities that demand high processing power. For example, activities related to collecting data about device performance, power usage, about user usage patterns, etc., may be completely suspended. The system may suspend displaying of images which may include bright color icons that may require additional computation power.

If the user attempts to access the Internet connected home electronic device, e.g. unlocking the smart door lock by scanning his/her fingerprint on the smart door lock or using the wireless local presence of the user's smartphone, the smart lock user interface notifies the user about the battery level of the device. This notification can be, e.g., an audible notification. The notification can include information such as the current battery level, number of operations/hours of operating time left.

Fig. 2 illustrates an example implementation of the electronic device sleep mode system 200. The system includes an Internet connected electronic door lock 202 built into the door of a user's house. The door lock may obtain its operating power from an internal 9 volt battery. The Internet connected electronic door lock is further comprised of an LCD display which is used to depict door lock information to the user. The information can include, e.g., current status 204 of the door lock (locked or unlocked), battery level 206 of the lock. The door lock is connected to the Internet via a built-in 3G radio and can notify its user (e.g., a resident of the house) whenever the door lock is accessed. The door unlocks whenever the user (resident of the house) taps a registered electronic device on to it. The lock may recognize the user's electronic device, which may include a digital key. The user may tap their electronic device on to door lock to unlock it and gain access to the house. In other scenarios, the door lock may also require biometric authentication from its user, requiring them to swipe their fingerprints in order to unlock the door.

The door lock can also be remotely controlled and managed by the user's personal electronic device, e.g., smartphone. For example, the user can set up the door lock from his smartphone to notify him/her whenever, e.g., certain designated people (with digital keys) unlock the door or when the door lock's battery reaches a certain threshold.

The door lock continues to operate normally until the point when its battery reaches a predetermined threshold level preset by the manufacturer or the user. The battery level can be, e.g., 10% of the overall battery capacity. When the battery level reaches the threshold battery level, the system causes a notification to be wirelessly transmitted to the user of the Internet connected electronic door lock. The notification is transmitted to the personal electronic device of the user.

Fig. 3 illustrates an example graphical user interface of a user's smartphone 302 on which the user receives the notification 304. As depicted, the notification indicates that the Internet connected electronic door lock device has reached a predetermined threshold level. The system displays the current battery level as well as a warning message, "Attention! Your Door Lock battery is at the low threshold Battery Level" 306 in the notification.

After the system causes this notification to be transmitted, the system places the Internet connected door lock in a sleep mode which includes turning off the onboard 3G radio and ceasing Internet communication. The system may also suspend high computational power tasks such as background tasks, collection of user usage data, lowering display brightness, etc. The sleep mode allows the electronic door lock to remain in a local operating state for an extended period of time.

Fig. 4 depicts an example implementation when the user tries to access the Internet connected electronic door lock 402 after receiving the threshold battery level notification. The user may tap his smartphone (with the digital key) onto the door lock and the door unlocked. The door lock display depicts the changed status, from locked to unlocked, and also displays the current battery level. The lock also delivers an audible notification 404 to the user regarding the current battery level of the door lock. The door lock may also be associated with a speaker system. The audible notification may be, e.g, "Attention, this lock is critically low on battery power and will only unlock/lock three more times." This local notification alerts the user to replace the door lock batteries immediately.

Fig. 5 is a block diagram of an exemplary environment that shows components of a system for implementing the techniques described in this disclosure. The environment includes client devices 510, servers 530, and network 540. Network 540 connects client devices 510 to

servers 530. Client device 510 is an electronic device. Client device 510 may be capable of requesting and receiving data/communications over network 540. Example client devices 510 are personal computers (e.g., laptops), mobile communication devices, (e.g. smartphones, tablet computing devices), set-top boxes, game-consoles, embedded systems. The other devices 510' that can send and receive data/communications over network 540 may be a physical hardware like a door lock to a room or automobile, an electronic safe lock, any other physical electronic locking appliance. Other examples of client device 510' can be smart appliances such as coolers, refrigerators, cold storages, chillers, ovens, stoves, microwaves, or any other home appliances. Client device 510 may execute an application, such as a web browser 512 or 514 or a native application 516. Web applications 513 and 515 may be displayed via a web browser 512 or 514. Server 530 may be a web server capable of sending, receiving and storing web pages 532. Web page(s) 532 may be stored on or accessible via server 530. Web page(s) 532 may be associated with web application 513 or 515 and accessed using a web browser, e.g., 512. When accessed, webpage(s) 532 may be transmitted and displayed on a client device, e.g., 510 or 510'. Resources 518 and 518' are resources available to the client device 510 and/or applications thereon, or server(s) 530 and/or web pages(s) accessible therefrom, respectively. Resources 518' may be, for example, memory or storage resources; a text, image, video, audio, JavaScript, CSS, or other file or object; or other relevant resources. Network 540 may be any network or combination of networks that can carry data communication.

The subject matter described in this disclosure can be implemented in software and/or hardware (for example, computers, circuits, or processors). The subject matter can be implemented on a single device or across multiple devices (for example, a client device and a server device). Devices implementing the subject matter can be connected through a wired

and/or wireless network. Such devices can receive inputs from a user (for example, from a mouse, keyboard, or touchscreen) and produce an output to a user (for example, through a display). Specific examples disclosed are provided for illustrative purposes and do not limit the scope of the disclosure.

DRAWINGS

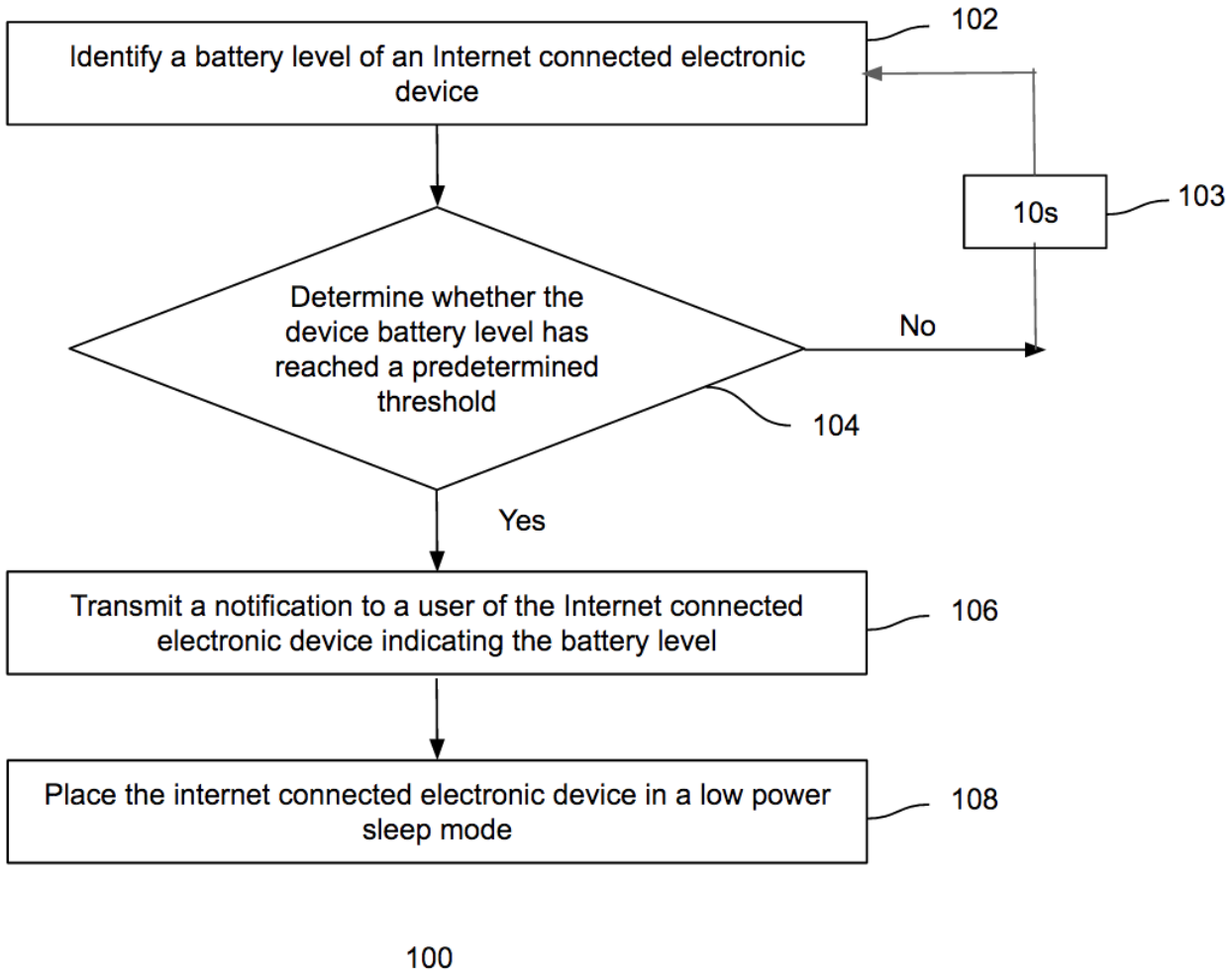
Identify a battery level of an Internet connected electronic device
102
10s
103
Determine whether the device battery level has reached a predetermined threshold
104
No
Yes
Transmit a notification to a user of the Internet connected electronic device indicating the battery level
106
Place the internet connected electronic device in a low power sleep mode
108
100

Fig. 1

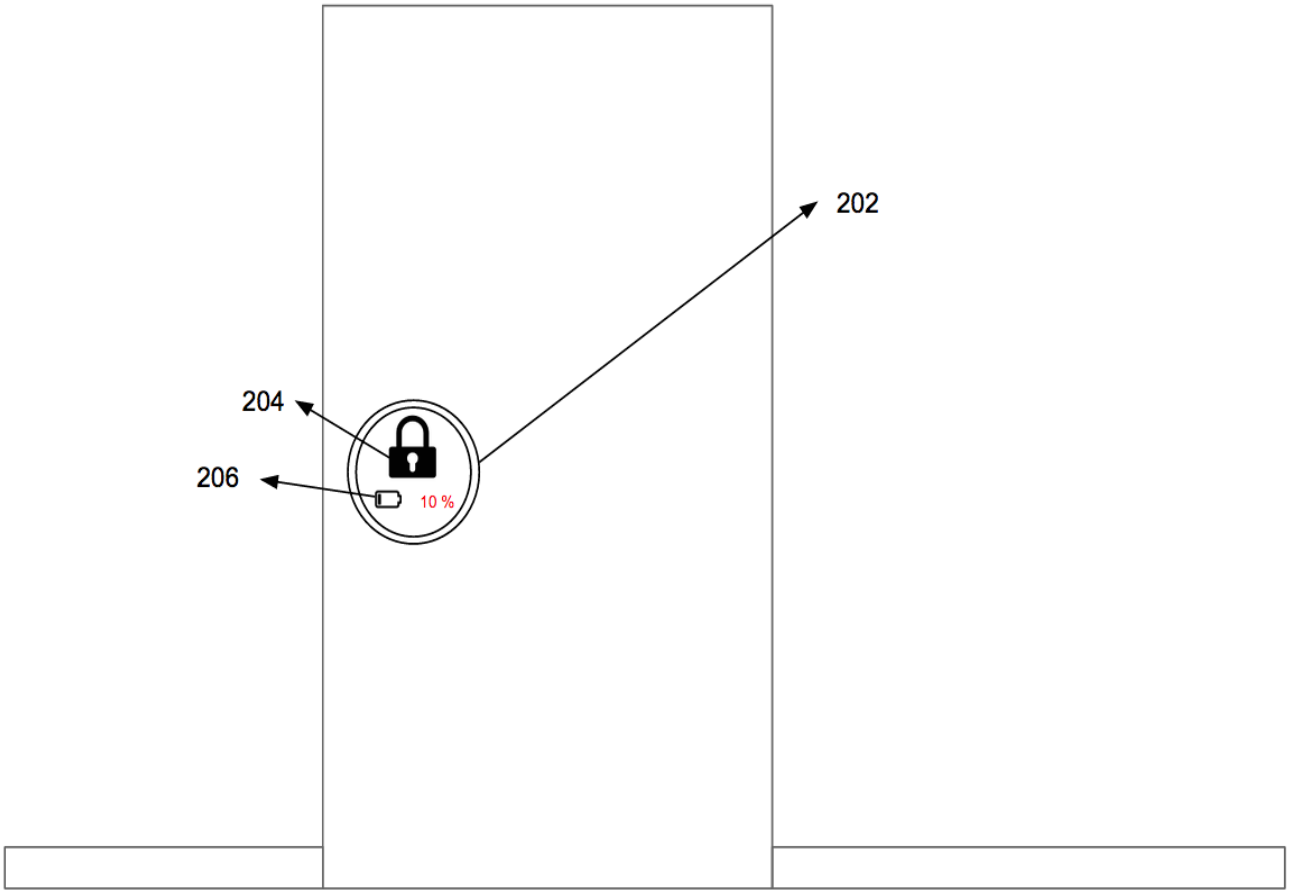

Fig. 2

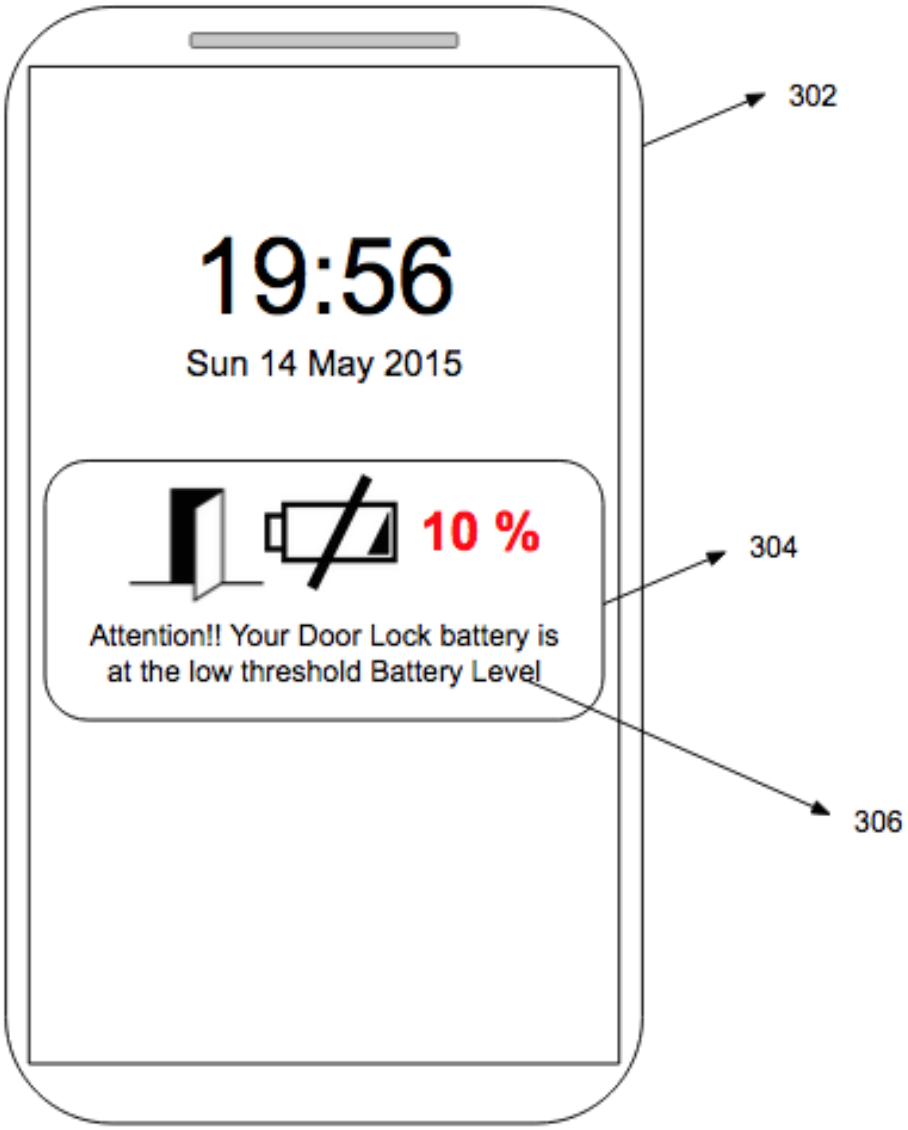
302
19:56
Sun 14 May 2015
10 %
304
Attention!! Your Door Lock battery is
at the low threshold Battery Level
306

Fig. 3

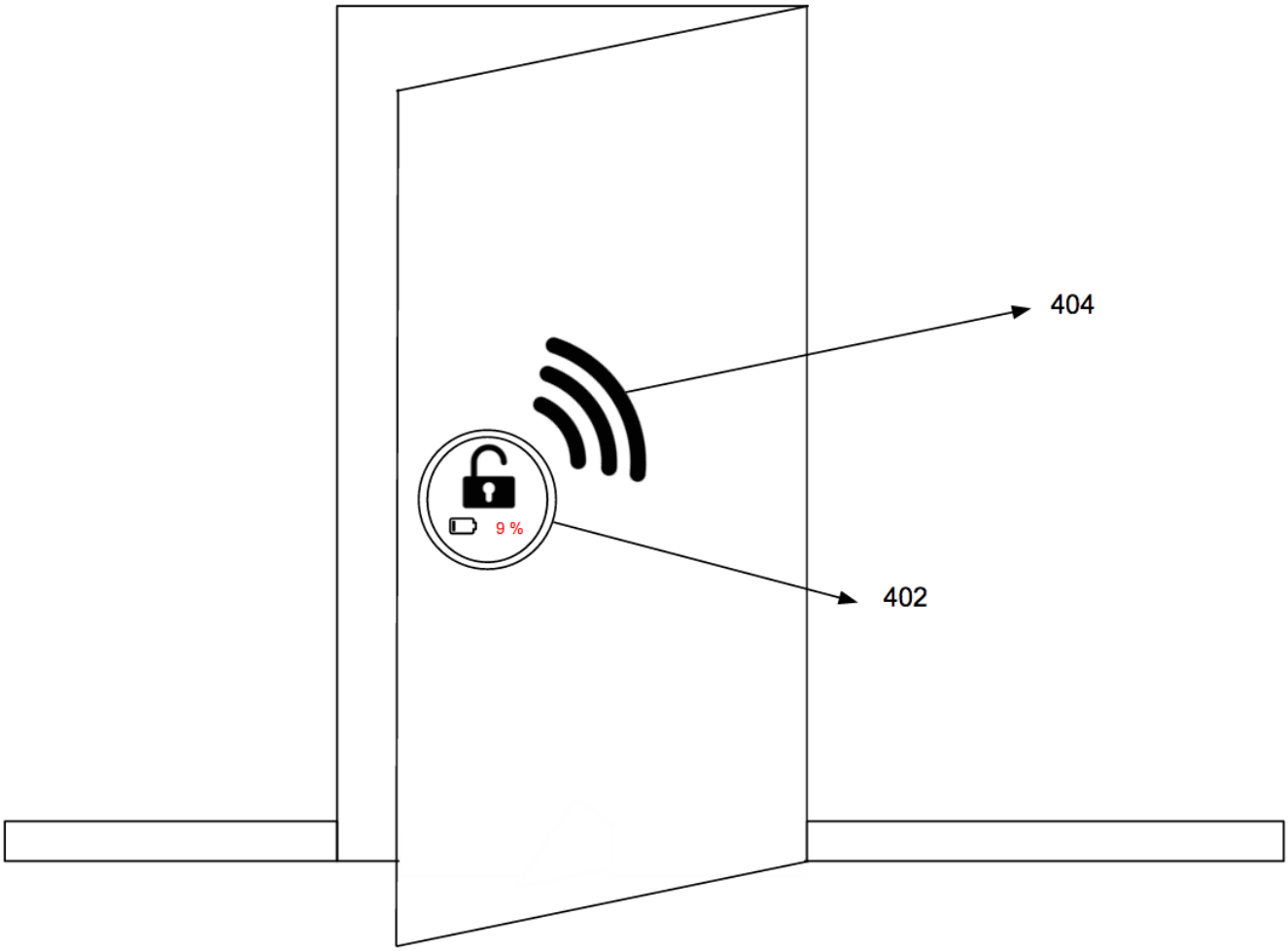

Fig. 4

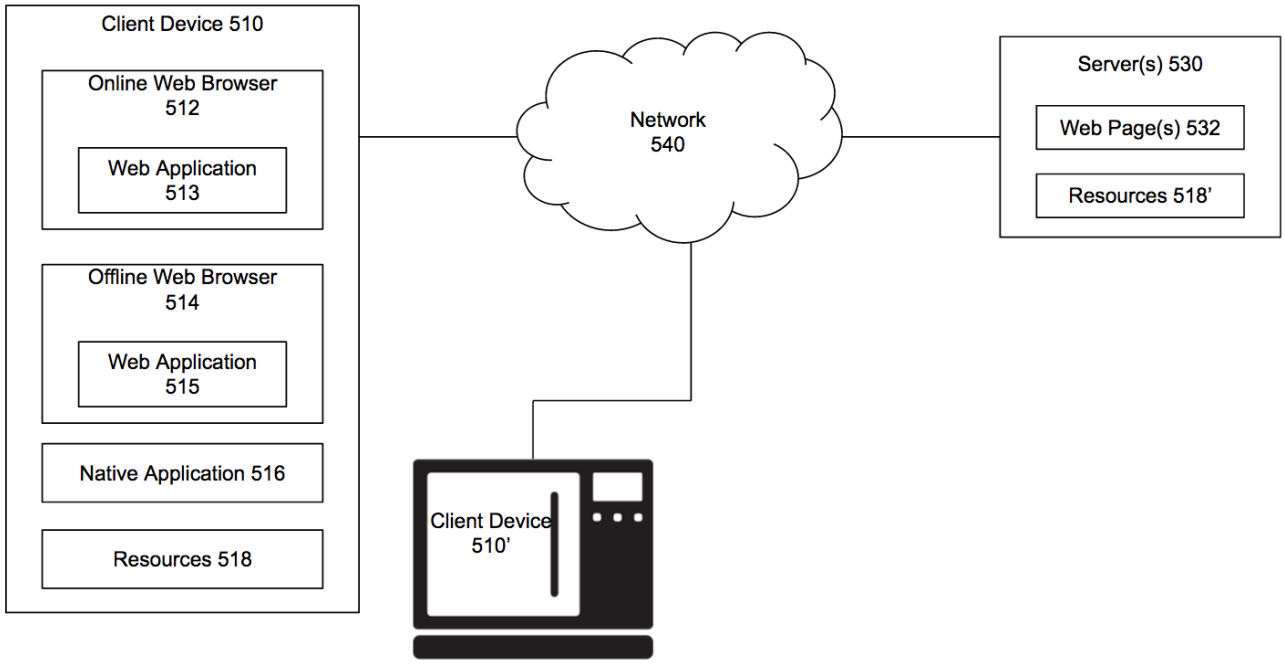
Client Device 510
Online Web Browser 512
Web Application 513
Offline Web Browser 514
Web Application 515
Native Application 516
Resources 518
Network 540
Server(s) 530
Web Page(s) 532
Resources 518'
Client Device 510'

Fig. 5