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(54) **REMOTE MONITORING SYSTEMS AND METHODS FOR MEDICAL DEVICES**

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(58) **Field of Classification Search**
None
See application file for complete search history.

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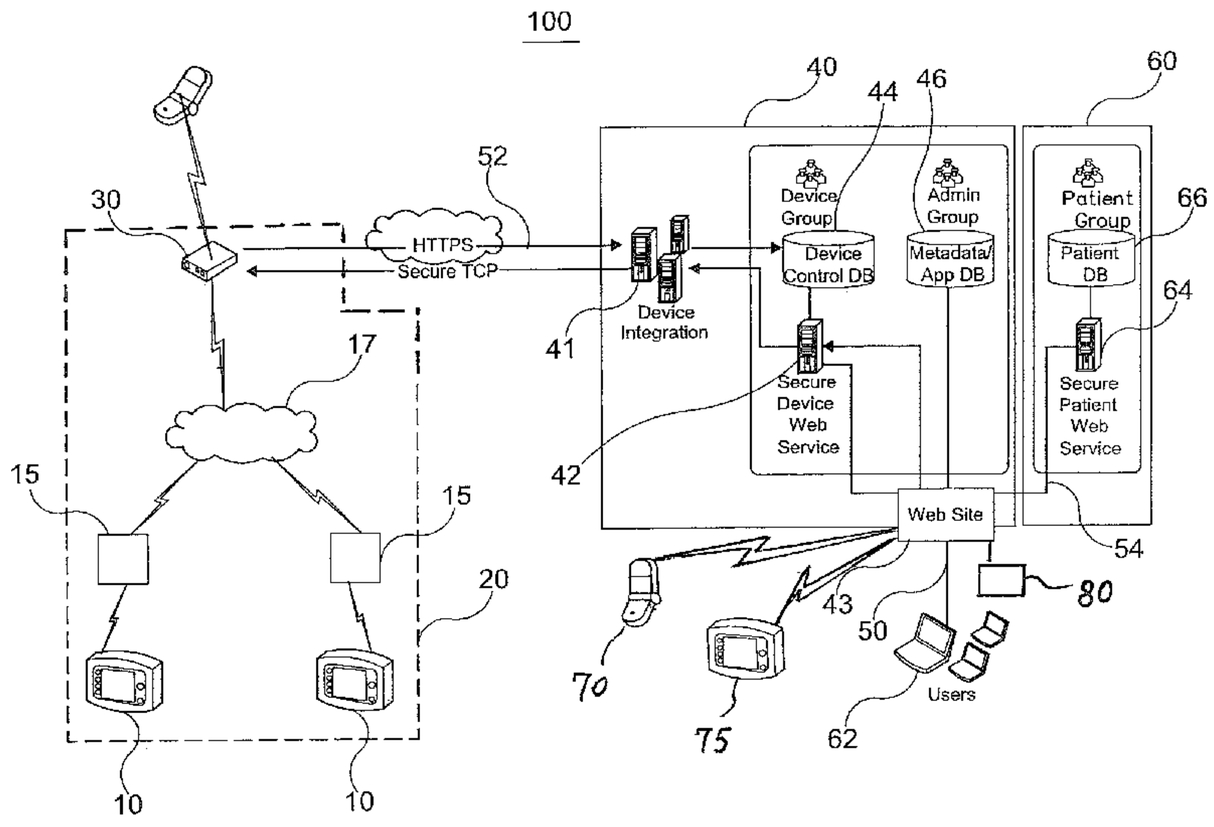
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(57) **ABSTRACT**

A remote monitoring system for monitoring a plurality of medical devices at a patient care or home care facility. The system includes a device integration server in communication with wireless relay modules for receiving data packets from the medical devices including an identifier and data for each medical device. The system also includes an outbound web server. The web server is configured to provide web-pages including the data of the medical devices for display on first and second remote monitoring devices, subject to authentication of an associated data request from the monitoring device.

24 Claims, 11 Drawing Sheets



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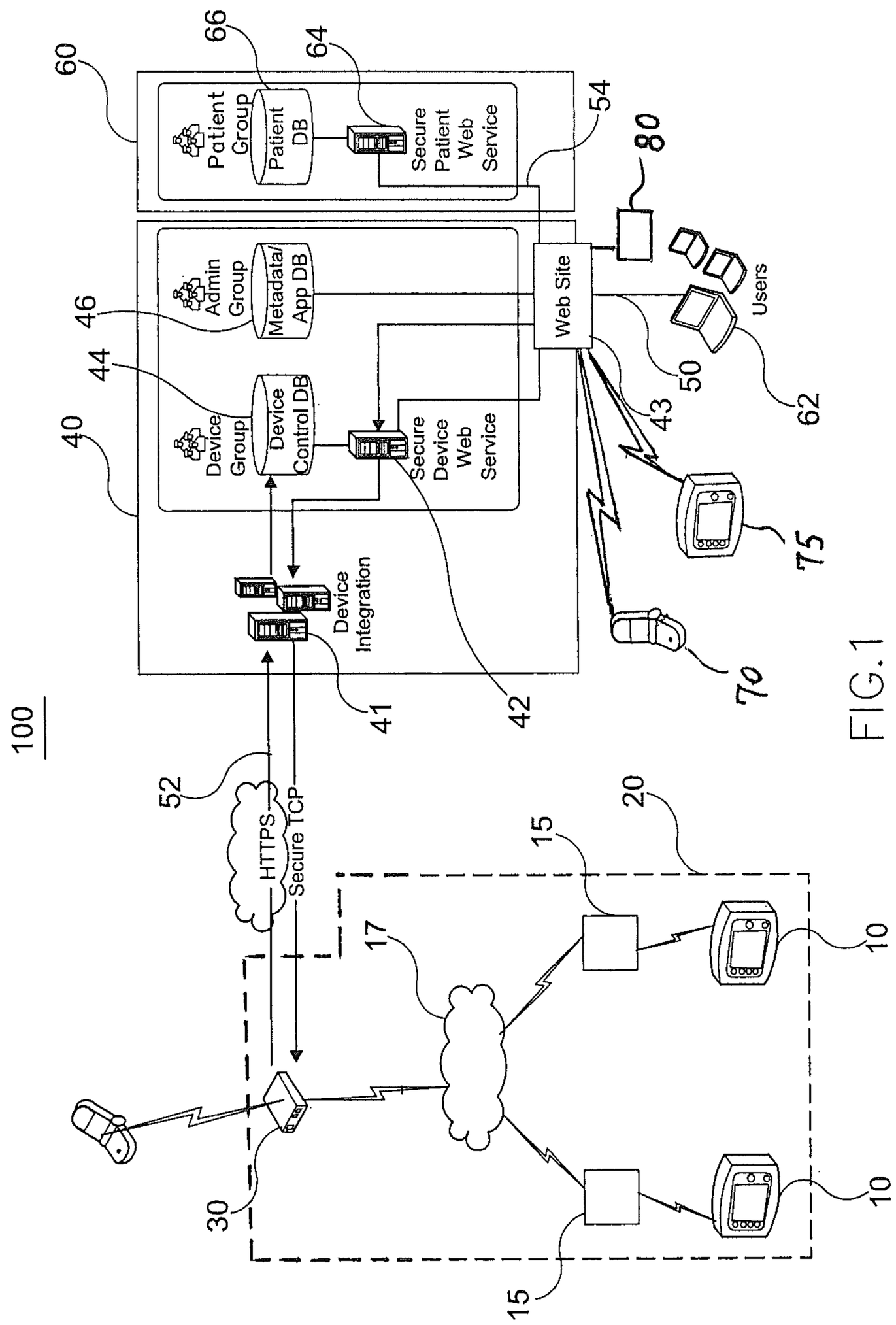

100
60
66
64
54
80
Patient Group
Patient DB
Secure Patient Web Service
Web Site
Users
62
50
43
75
70
Admin Group
Metadata/ App DB
46
44
Device Group
Device Control DB
Secure Device Web Service
40
Device Integration
41
42
52
HTTPS
Secure TCP
20
15
17
10
30
15

FIG. 1

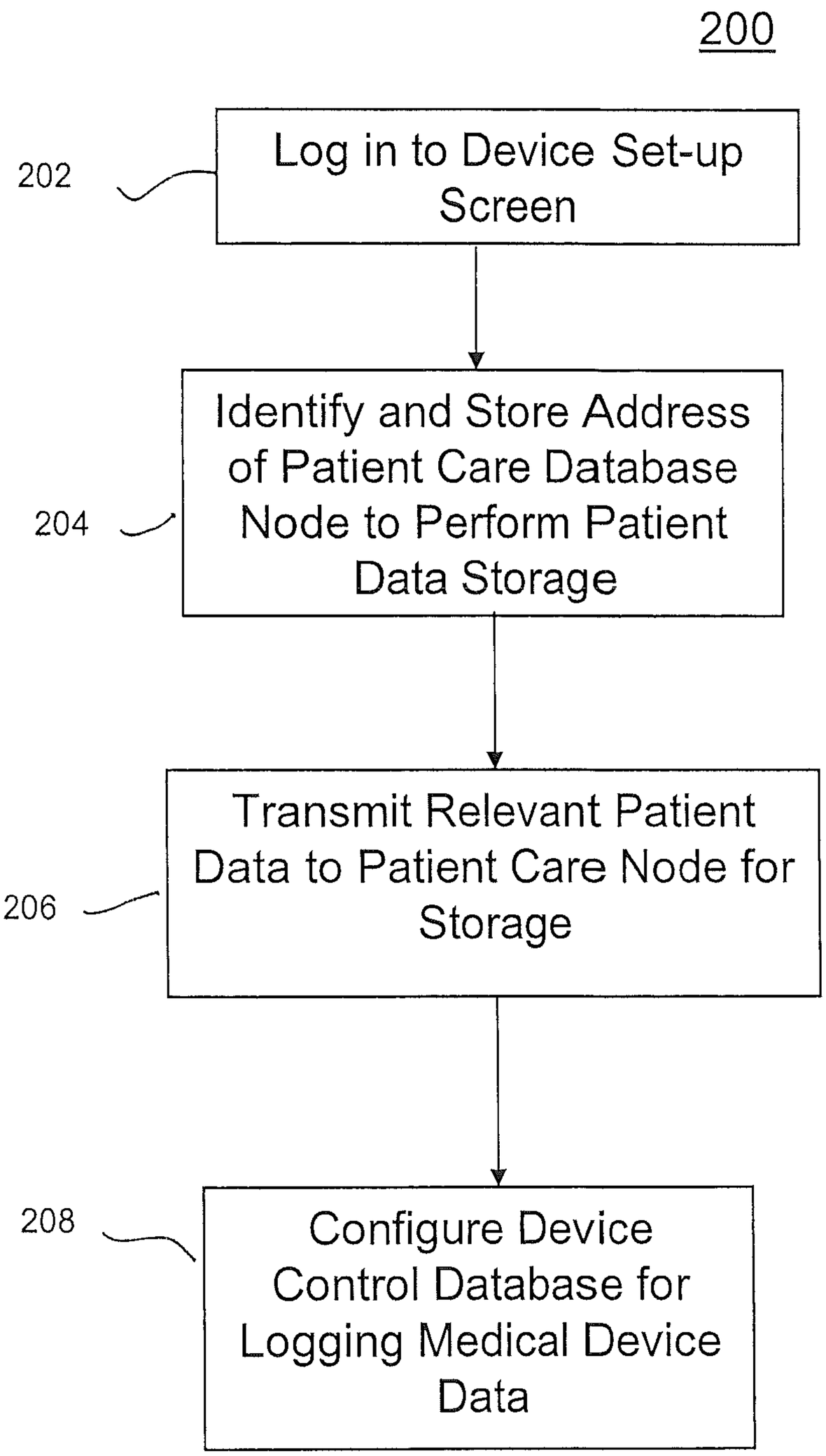

200
202
Log in to Device Set-up Screen
204
Identify and Store Address of Patient Care Database Node to Perform Patient Data Storage
206
Transmit Relevant Patient Data to Patient Care Node for Storage
208
Configure Device Control Database for Logging Medical Device Data

FIG. 2

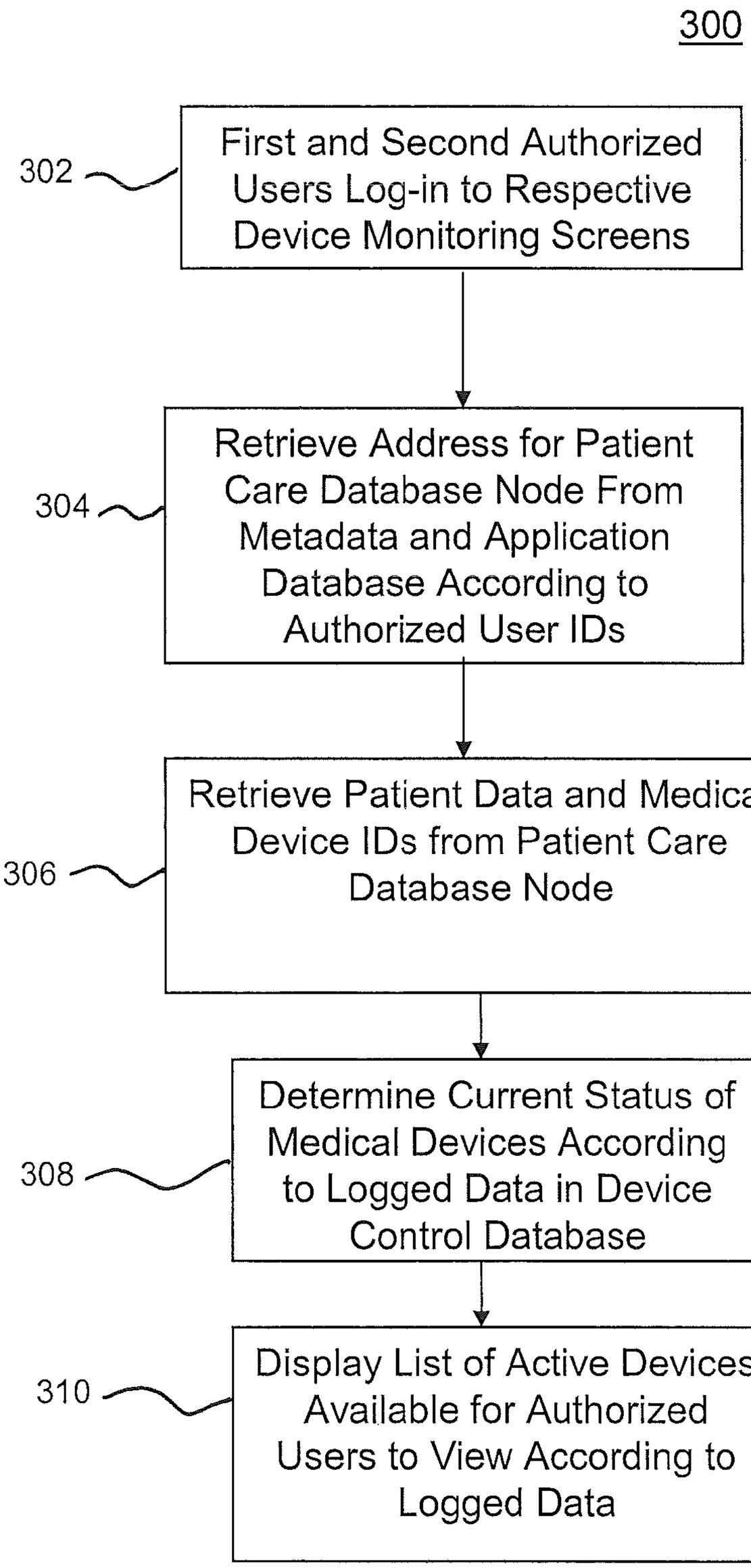

300
302
First and Second Authorized Users Log-in to Respective Device Monitoring Screens
304
Retrieve Address for Patient Care Database Node From Metadata and Application Database According to Authorized User IDs
306
Retrieve Patient Data and Medical Device IDs from Patient Care Database Node
308
Determine Current Status of Medical Devices According to Logged Data in Device Control Database
310
Display List of Active Devices Available for Authorized Users to View According to Logged Data

FIG. 3 (a)

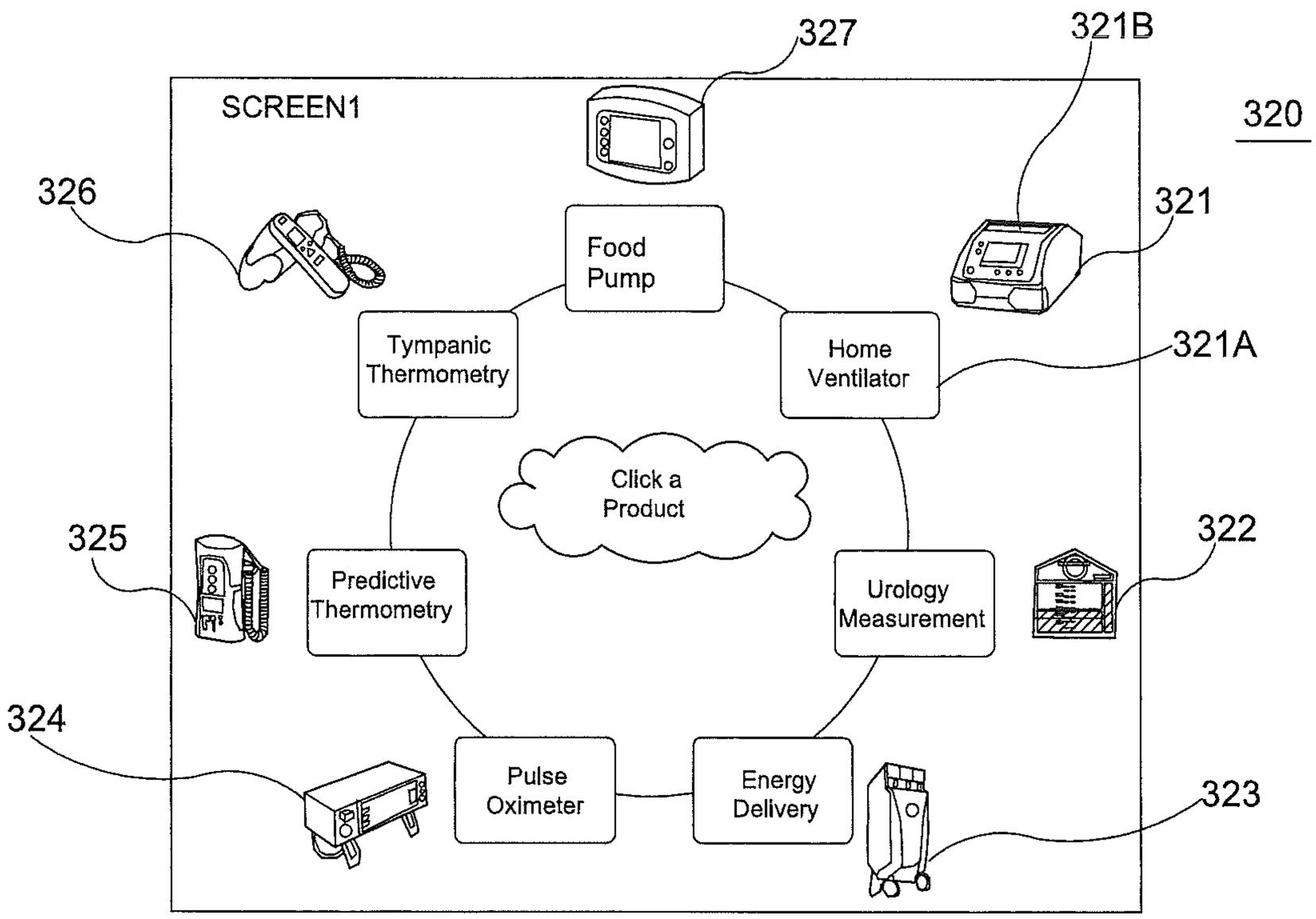

SCREEN1
320
327
321B
326
321
Food Pump
Tympanic Thermometry
Home Ventilator
321A
Click a Product
325
Predictive Thermometry
Urology Measurement
322
324
Pulse Oximeter
Energy Delivery
323

FIG.3 (b)

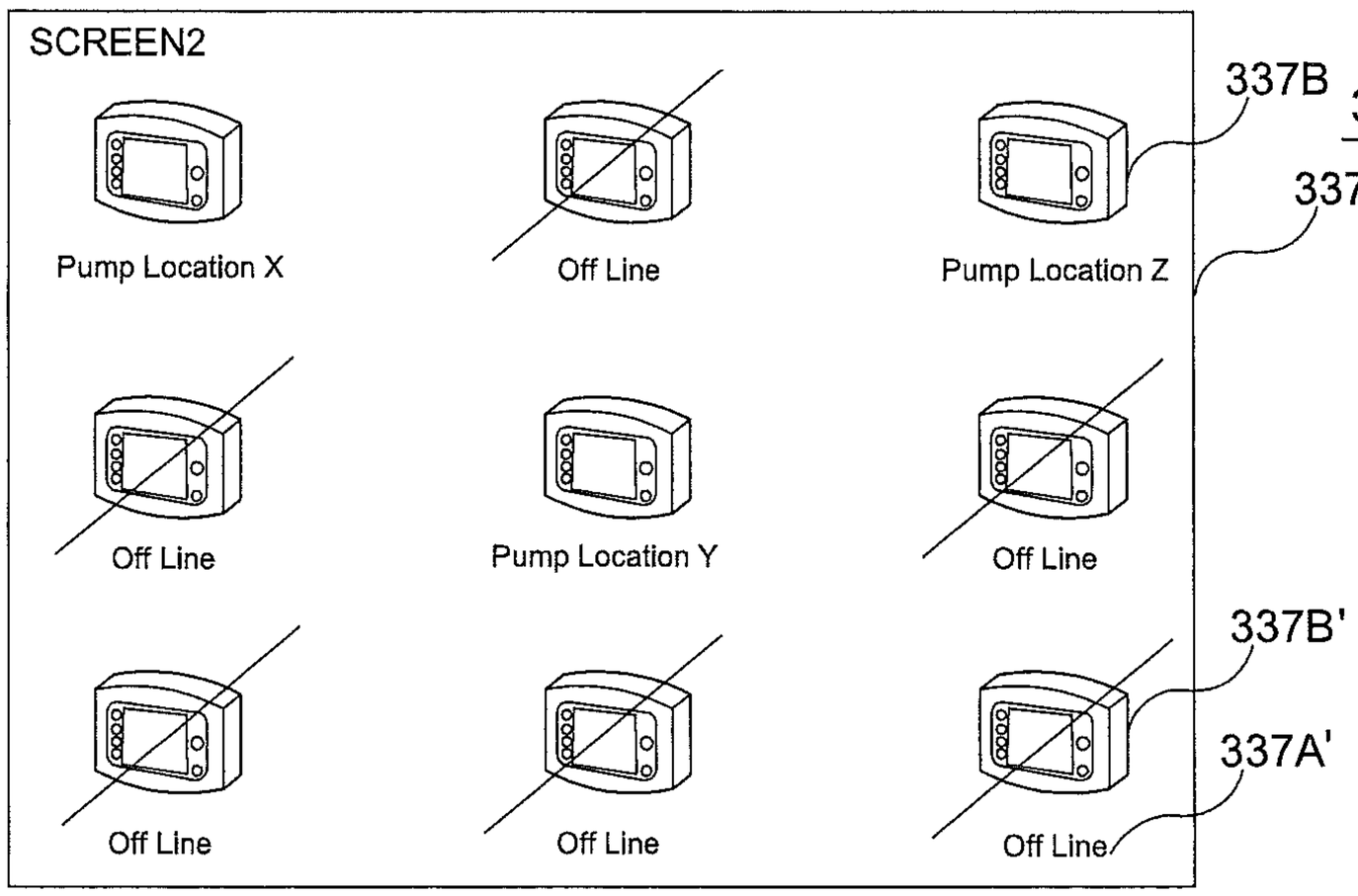

SCREEN2
337B
330
337A
Pump Location X
Off Line
Pump Location Z
Off Line
Pump Location Y
Off Line
337B'
337A'
Off Line
Off Line
Off Line

FIG.3 (C)

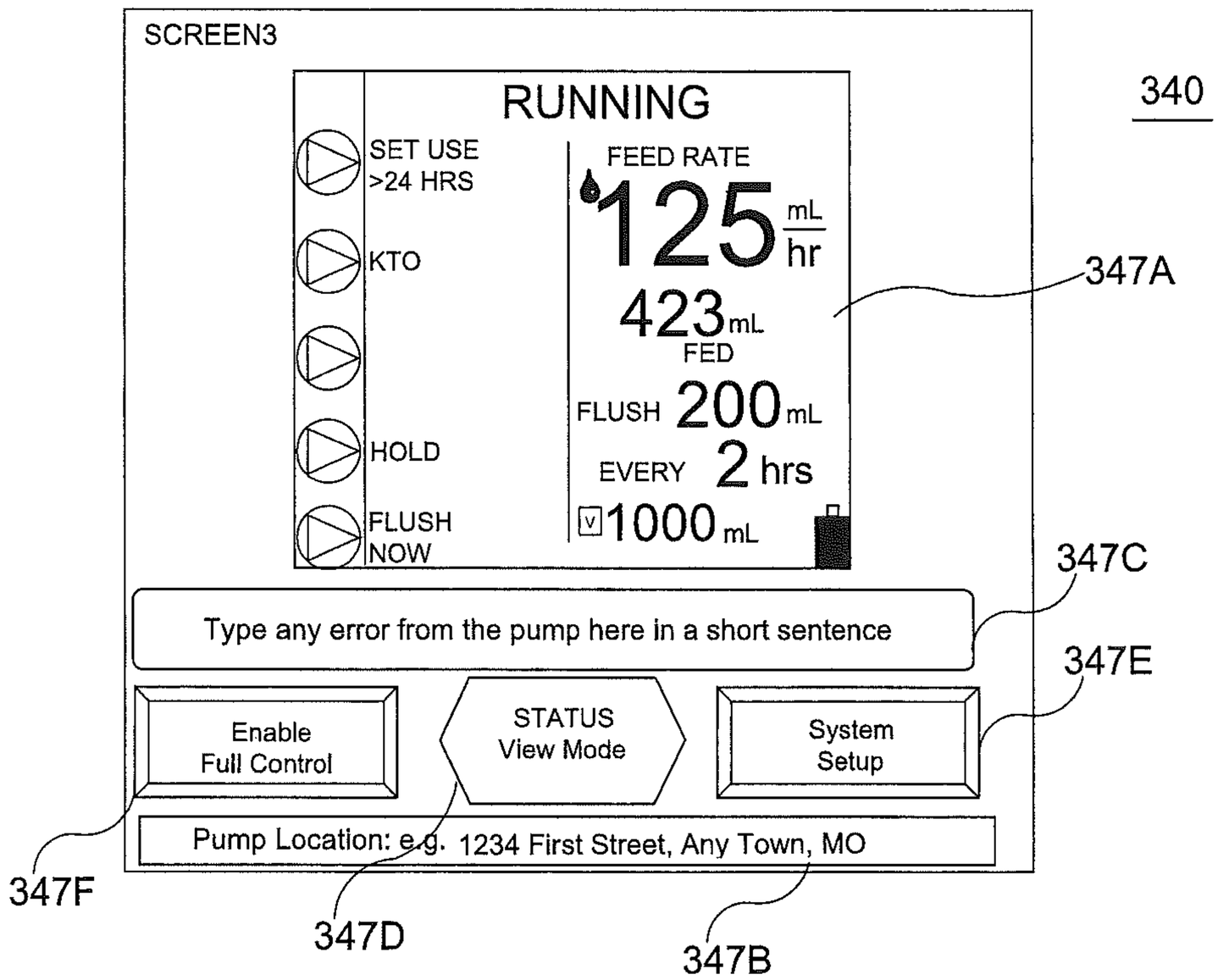

SCREEN3
RUNNING
SET USE >24 HRS
KTO
HOLD
FLUSH NOW
FEED RATE
125 mL/hr
423 mL FED
FLUSH 200 mL
EVERY 2 hrs
1000 mL
Type any error from the pump here in a short sentence
Enable Full Control
STATUS View Mode
System Setup
Pump Location: e.g. 1234 First Street, Any Town, MO
340
347A
347C
347E
347F
347D
347B

FIG.3 (d)

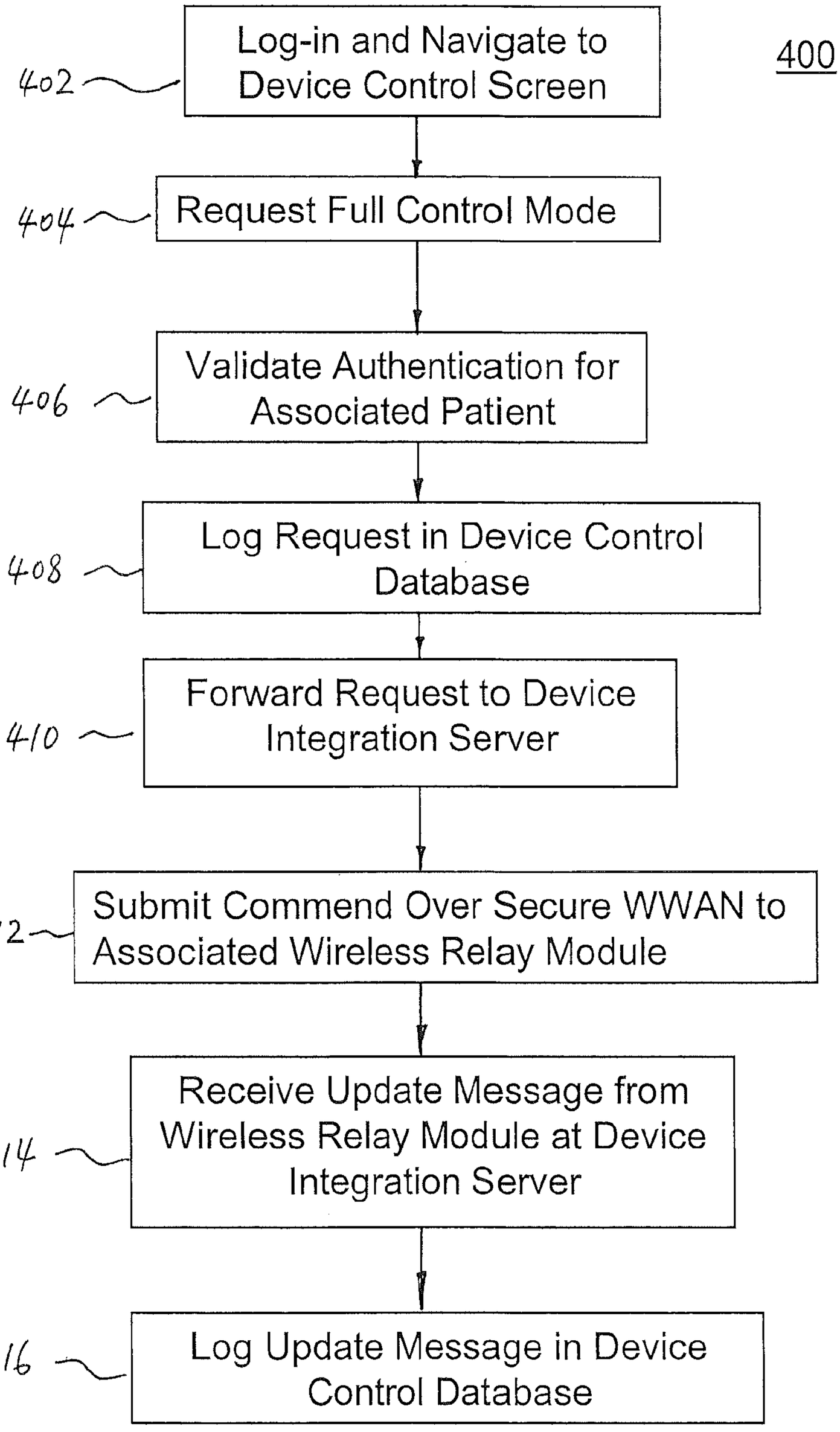

400
402
Log-in and Navigate to Device Control Screen
404
Request Full Control Mode
406
Validate Authentication for Associated Patient
408
Log Request in Device Control Database
410
Forward Request to Device Integration Server
412
Submit Commend Over Secure WWAN to Associated Wireless Relay Module
414
Receive Update Message from Wireless Relay Module at Device Integration Server
416
Log Update Message in Device Control Database

FIG. 4(a)

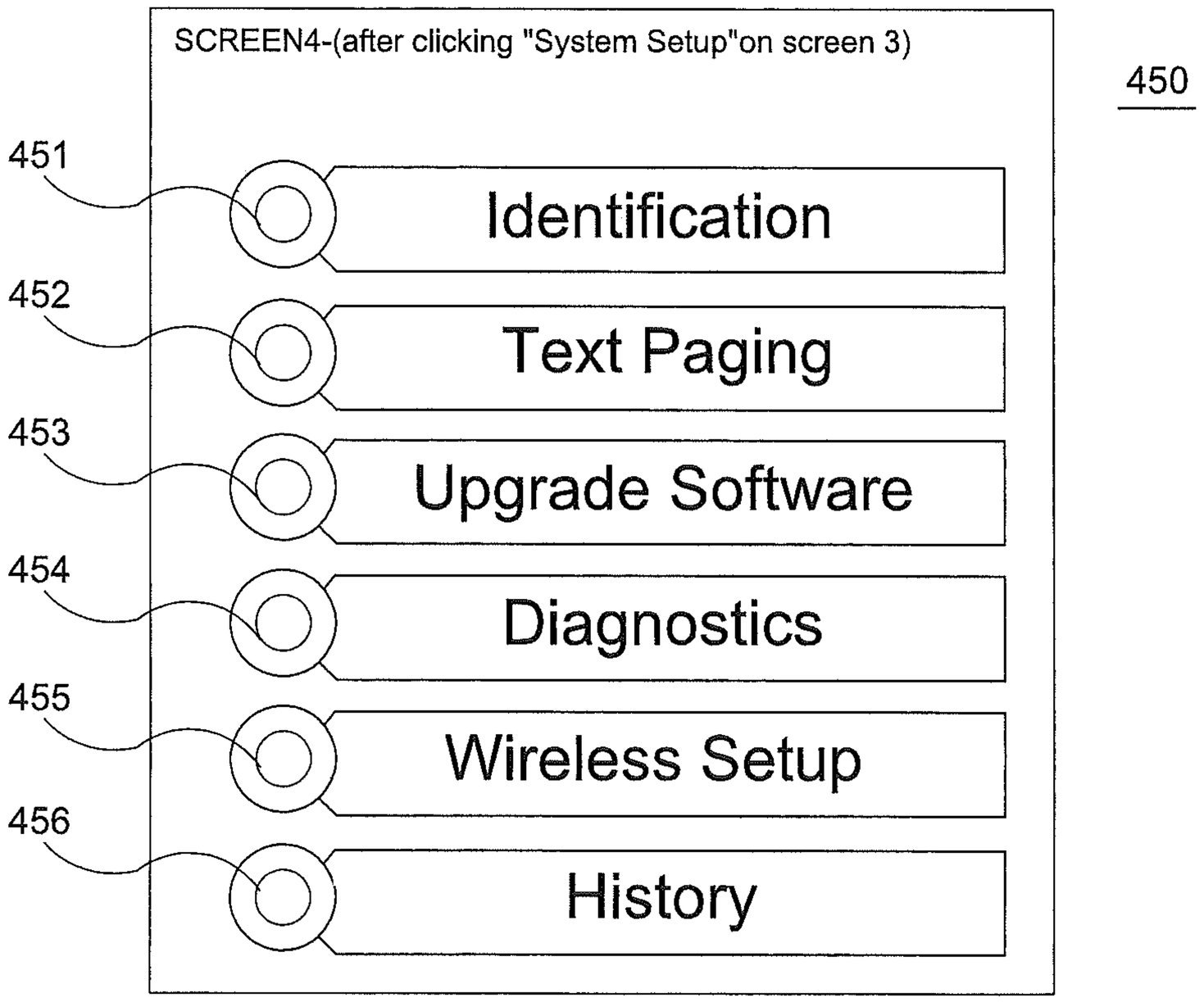

SCREEN4-(after clicking "System Setup"on screen 3)
450
451
Identification
452
Text Paging
453
Upgrade Software
454
Diagnostics
455
Wireless Setup
456
History

FIG.4 (b)

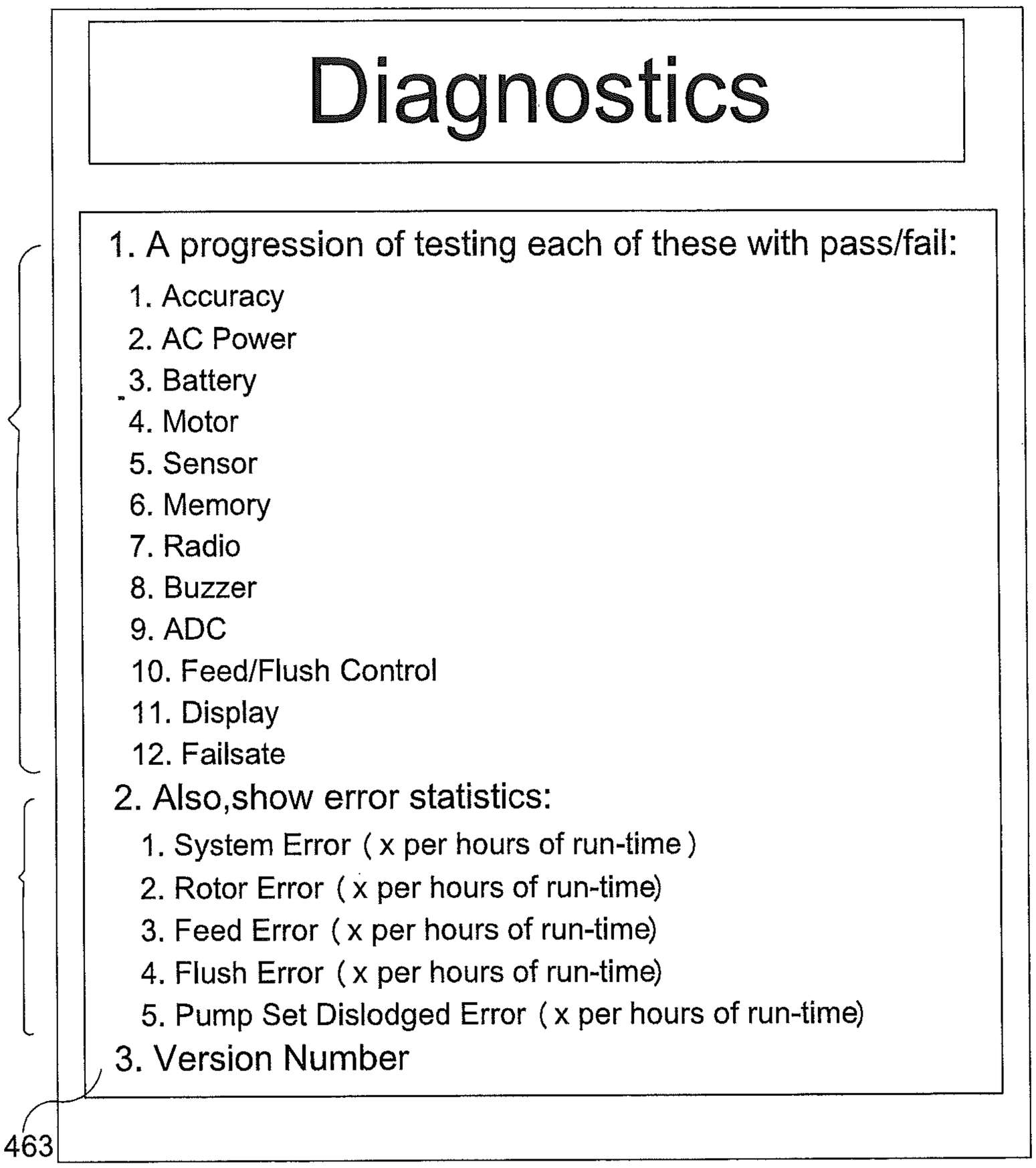

460
Diagnostics
1. A progression of testing each of these with pass/fail:
1. Accuracy
2. AC Power
3. Battery
4. Motor
5. Sensor
6. Memory
7. Radio
8. Buzzer
9. ADC
10. Feed/Flush Control
11. Display
12. Failsate
461
2. Also,show error statistics:
1. System Error (x per hours of run-time)
2. Rotor Error (x per hours of run-time)
3. Feed Error (x per hours of run-time)
4. Flush Error (x per hours of run-time)
5. Pump Set Dislodged Error (x per hours of run-time)
462
3. Version Number
463

FIG.4 (c)

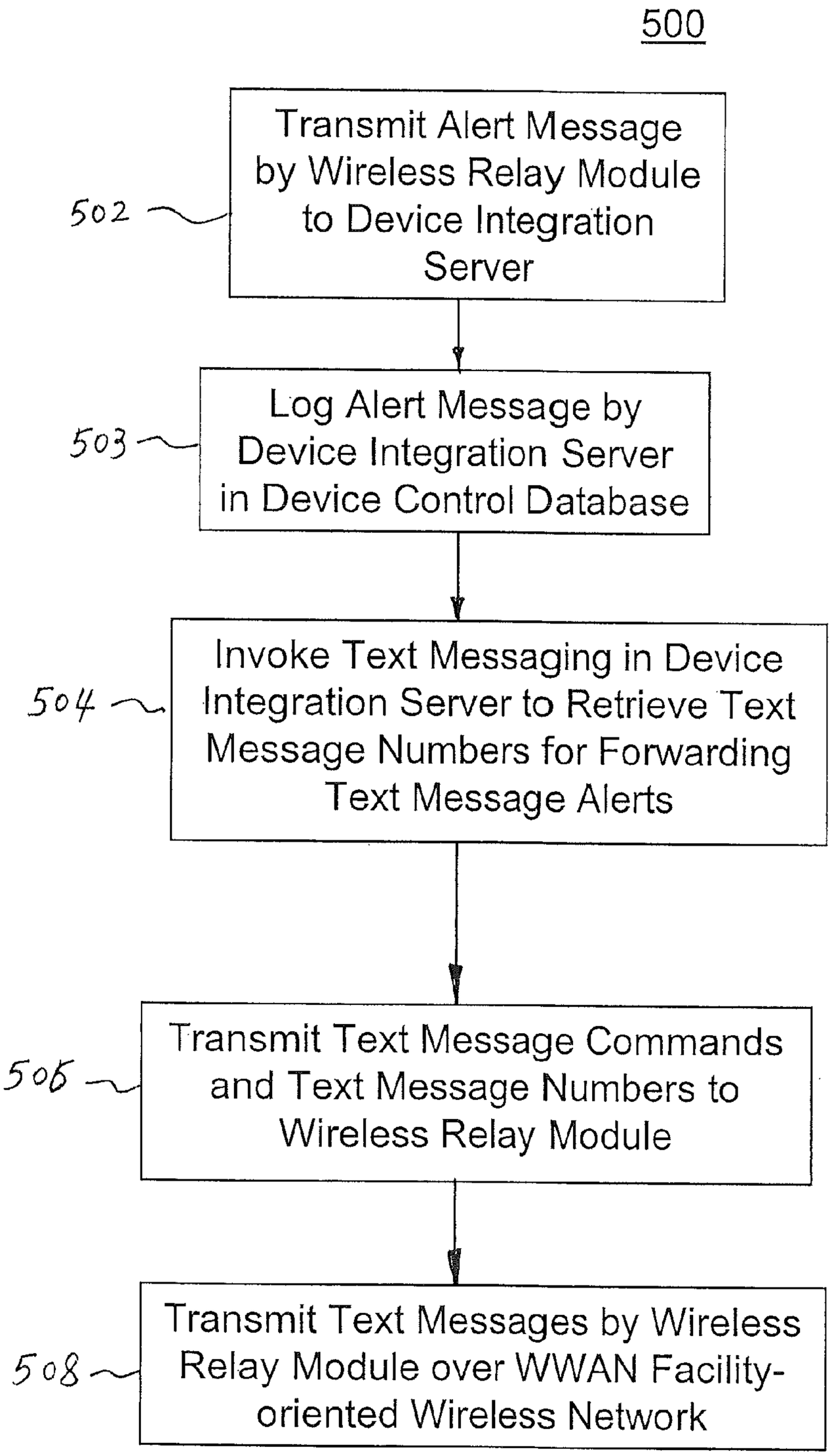

500
502
Transmit Alert Message by Wireless Relay Module to Device Integration Server
503
Log Alert Message by Device Integration Server in Device Control Database
504
Invoke Text Messaging in Device Integration Server to Retrieve Text Message Numbers for Forwarding Text Message Alerts
506
Transmit Text Message Commands and Text Message Numbers to Wireless Relay Module
508
Transmit Text Messages by Wireless Relay Module over WWAN Facility-oriented Wireless Network

FIG. 5(a)

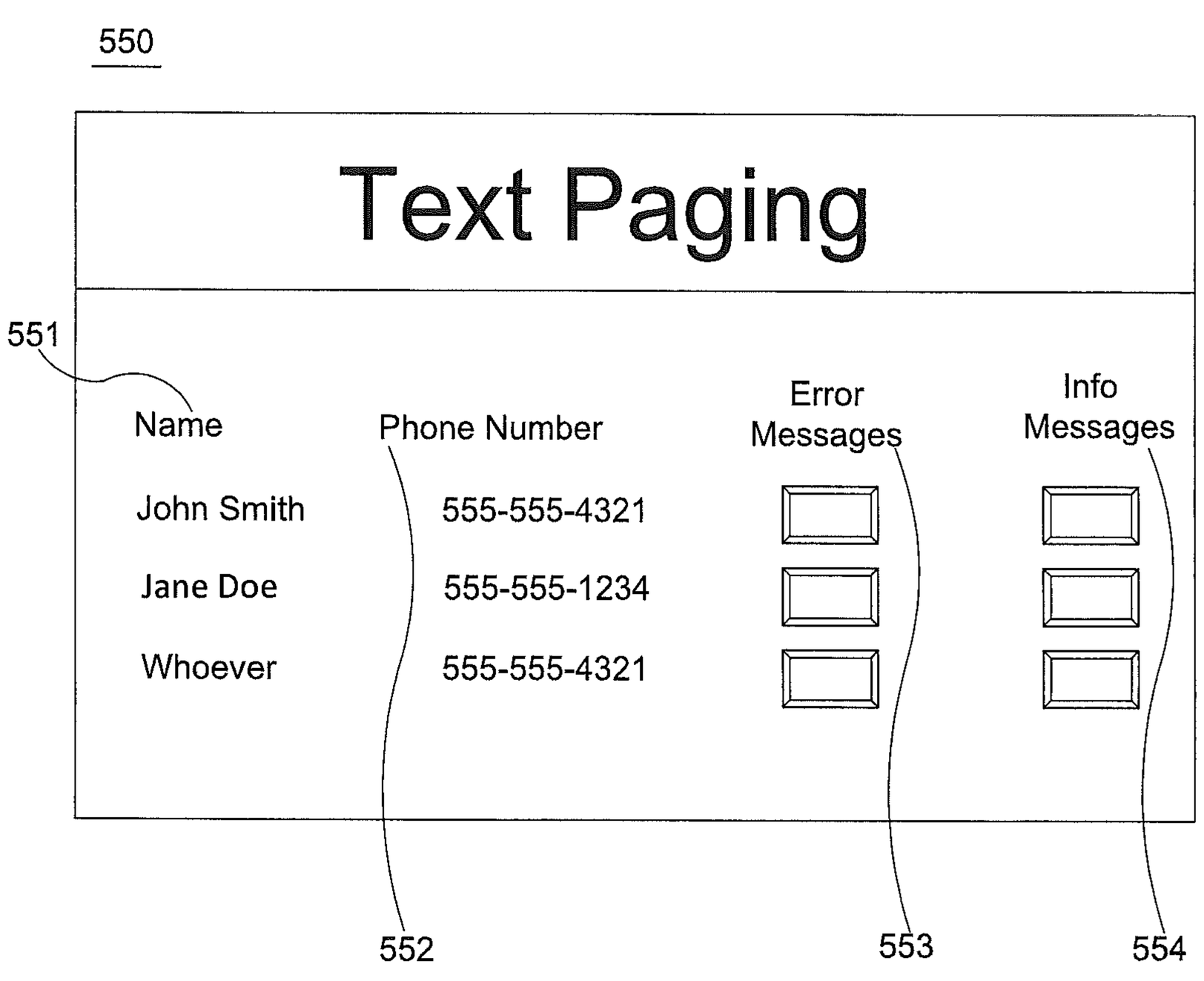

550
Text Paging
551
Name
Phone Number
Error Messages
Info Messages
John Smith
555-555-4321
Jane Doe
555-555-1234
Whoever
555-555-4321
552
553
554

FIG.5 (b)

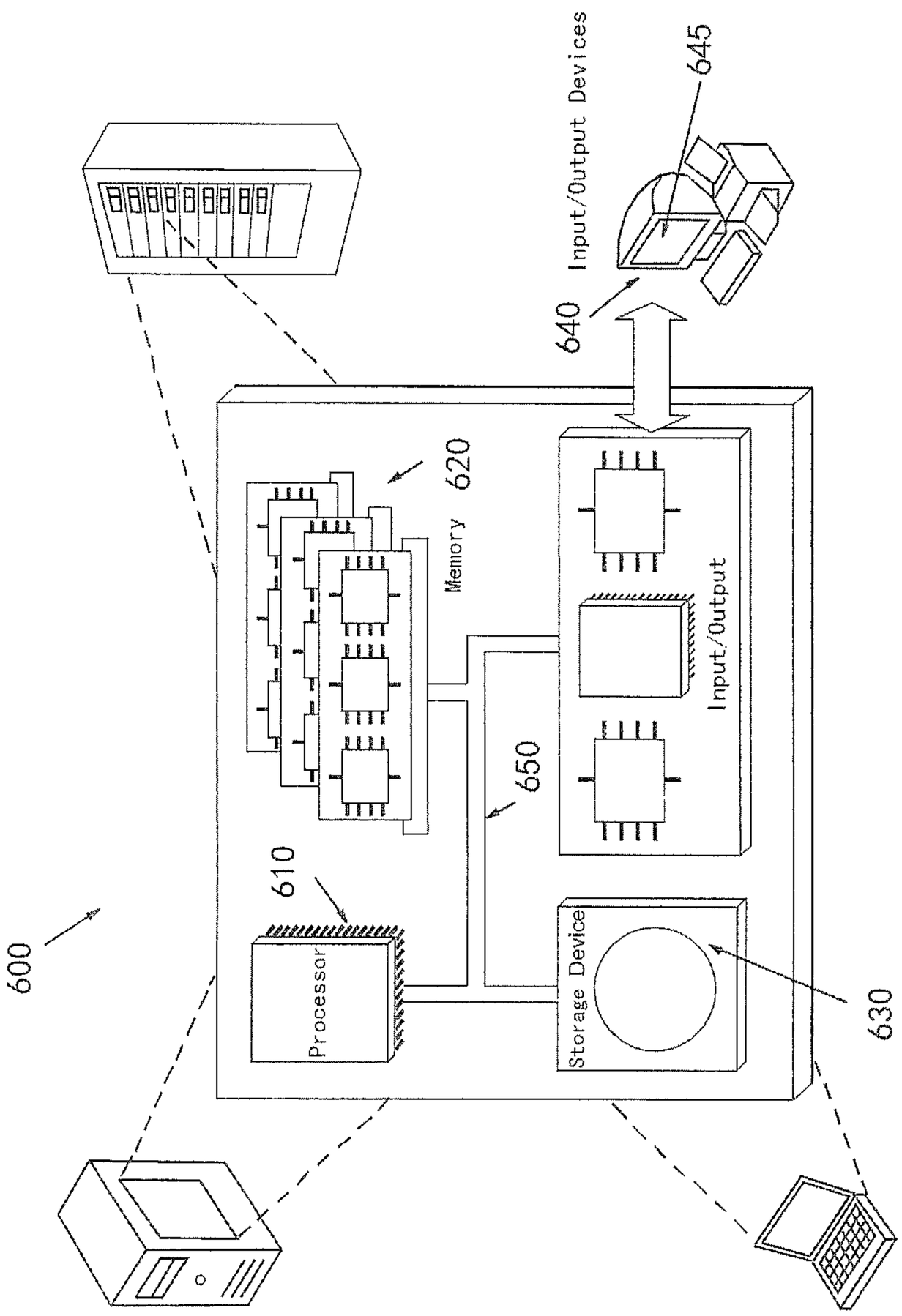

600
610
Processor
620
Memory
630
Storage Device
640
Input/Output Devices
645
650
Input/Output

FIG.6

REMOTE MONITORING SYSTEMS AND METHODS FOR MEDICAL DEVICES

RELATED APPLICATIONS

This application is a continuation-in-part patent application of U.S. application Ser. No. 13/037,886, filed Mar. 1, 2011, entitled "Remote Monitoring Systems For Monitoring Medical Devices Via Wireless Communication Networks," which is incorporated by reference in its entirety herein for all purposes.

FIELD OF THE INVENTION

The present application is directed to a remote monitoring system for monitoring medical devices in communication with a wireless communication network, and more particularly, to a remote monitoring system having a plurality of monitoring devices for monitoring medical devices that communicate with the wireless communication network via one or more wireless relay modules and a wireless relay network.

BACKGROUND OF THE INVENTION

In critical care and home care health service centers, including hospitals, clinics, assisted living centers and the like, care giver-patient interaction time is at a premium. Moreover, response times by care givers to significant health conditions and events can be critical. Systems of centralized monitoring have been developed to better manage care giver time and patient interaction. In such systems, physiological data from each patient is transmitted to a centralized location. At this centralized location, a single or small number of technicians monitor all of this patient information to determine patient status. Information indicating a patient alarm condition will cause the technicians and/or system to communicate with local care givers to provide immediate patient attention, for example via wireless pagers and/or cell phones, and/or by making a facility-wide audio page.

Implementing such centralized monitoring systems using wireless networks may present a number of difficulties. In order to effectively monitor patient status using information provided by a variety of medical devices that may be dynamically assigned to patients in a variety of rooms and on a variety of floors in a facility, it would be desirable to establish communications between the medical devices and the centralized location by means of a local area network such as, for example, a "WiFi" network based on IEEE 802.11 standards. However, as such networks are typically already in place in facilities to support a variety of other functions (for example, physician access to electronic medical records (EMRs), facility administrative systems and other functions), it is often undesirable to secure sufficient local area network access for the purpose of providing centralized monitoring. Moreover, when a patient is located remotely from a critical care health service center (for example, at home), access to traditional local area network facilities such as a WiFi network may be unavailable or not sufficiently reliable to support critical care monitoring applications.

For improved efficiencies in centralized monitoring of critical care and home care health service centers, it may be desirable to provide a single "off-site" centralized monitoring location for monitoring several geographically-dispersed critical care health service centers.

As an alternative to conventional WiFi or IEEE 801.11-based local area networks, ZIGBEE networks based on the IEEE 802.15.4 standard for wireless personal area networks have been used for collecting information from a variety of medical devices in accordance with IEEE 11073 Device Specializations for point-of-care medical device communication, including for example pulse oximeters, blood pressure monitors, pulse monitors, weight scales and glucose meters. See, e.g., *ZIGBEE Wireless Sensor Applications for Health, Wellness and Fitness*, the ZIGBEE Alliance, March 2009, which is incorporated by reference herein in its entirety. As compared to present IEEE 802.15.1 Bluetooth wireless personal area networks, for example, ZIGBEE networks provide the advantage of being dynamically configurable, for example, in "self-healing" mesh configurations, and operating with low power requirements (enabling, for example, ZIGBEE transceivers to be integrally coupled to the medical devices under battery power). However, transmission ranges between individual ZIGBEE transceivers are generally limited to no more than several hundred feet. As a consequence, such networks are suitable for on-site communications with medical devices, but unusable for centralized monitoring locations located off-site.

Therefore, a hybrid system may be employed in which one or more wireless personal area networks are configured to facilitate on-site communications between medical devices and one or more wireless relay modules which are further configured to communicate with off-site centralized monitoring systems (for example, via a wireless wide-area network (WWAN) such as a mobile telephone data network, for example, based on a Global System for Mobile Communications (GSM) or Code Division Multiple Access (CDMA) cellular network or associated wireless data channels). Such a relay module and system are respectively described in the related patent applications entitled "Wireless Relay Module for Remote Monitoring Systems," U.S. application Ser. No. 13/006,769, filed Jan. 14, 2011 and "Medical Device Wireless Network Architectures," U.S. application Ser. No. 13/006,784, filed Jan. 14, 2011) which have been incorporated by reference herein for all purposes.

In accordance with applicable patient data privacy provisions of the Health Insurance Portability and Accountability Act of 1996 (HIPAA), communication of information between the monitored medical devices and the central monitoring location must be done securely, and medical device and associated patient information must be made available only to personnel accessing the centralized monitoring systems who are in possession of the appropriate access credentials. In order to be viable, the centralized monitoring system must also be capable of recognizing medical device information indicating an alert condition requiring response by on-site or other specialized personnel and reaching those on-site or specialized personnel to report the alert condition in a timely fashion.

Thus, it would be desirable to provide a remote, centralized medical information monitoring system that communicates over a wireless network of wide reach (for example, a wireless wide area network) with one or more critical care and/or home care health service centers via one or more wireless relay modules at each site, where the wireless relay modules relay communications provided by on-site medical devices over a wireless local area network or wireless personal area network. It would further be desirable for the centralized medical information monitoring system to be capable of also configuring medical devices according to associations with individual sites and patients, of logging communications from medical devices, of displaying medi-

cal device data to users of the centralized medical information monitoring system who are able to provide sufficient credentials, and of recognizing medical device alert conditions and reporting these conditions to responsible personnel in a timely fashion.

SUMMARY OF THE INVENTION

The present invention is directed to a remote monitoring system and method for monitoring the status of a plurality of medical devices located remotely from the monitoring system at a patient care or home care facility. In accordance with one embodiment of the invention, one or more medical devices (including but not limited to respirators, enteral feeding devices, pulse oximeters, blood pressure monitors, pulse monitors, weight scales and glucose meters) are provided at a patient care or home care facility. An interface circuit is coupled to each medical device, and is configured for communicating with one of a plurality of the wireless relay modules via a wireless relay network. The wireless relay modules are further configured to communicate with the remote monitoring device over an internet-accessible wireless communication network, and preferably, a wireless wide-area network (WWAN) such as a mobile telephone data network including (for example, based on a Global System for Mobile Communications (GSM) or Code Division Multiple Access (CDMA) cellular network or associated wireless data channels). Also, for compliance for example with HIPAA regulations, communications over each of the wireless networks are preferably conducted securely.

The remote monitoring system and method includes a device integration server in communication with the wireless relay modules for receiving data packets from the wireless relay modules including information provided by the medical devices. This information includes identification of an associated medical device and may include data of the medical device, and is preferably encrypted or otherwise securely transmitted, for example, in compliance with HIPAA patient data privacy provisions. In addition, the information may include encrypted or otherwise securely transmitted patient identification information, which in addition may preferably be coded in its unencrypted state to avoid any reference to the patient's identity.

The remote monitoring system also includes a data management system including a secure device web server and a device control database, and an outbound web server. The data management system is configured to log information provided to the device integration server concerning the medical devices. The outbound web server (alternatively referred to as "web server" herein) is configured to provide webpages including the data of the medical devices for display on a first and second remote monitoring devices, subject to authentication of an associated data request originating from the monitoring device. The second monitoring device may advantageously be for use by a relative of the patient, such as a parent, caregiver or nurse, who may be located proximate or remote to the patient.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will become more readily apparent from the Detailed Description of the Invention, which proceeds with reference to the drawings, in which:

FIG. **1** presents a block diagram of an exemplary remote monitoring system for remotely monitoring medical devices according to the present invention;

FIG. **2** presents a flow diagram illustrating an exemplary method for registering medical devices with the remote monitoring system according to FIG. **1**;

FIG. **3**(*a*) presents a flow diagram illustrating an exemplary method for retrieving and viewing medical data via the remote monitoring system according to FIG. **1**;

FIGS. **3**(*b*)-**3**(*d*) illustrate exemplary screen displays for retrieving and viewing the medical data according to the method of FIG. **3**(*a*);

FIG. **4**(*a*) presents a flow diagram illustrating an exemplary method for issuing a command to a medical device via the remote monitoring system according to FIG. **1**;

FIGS. **4**(*b*) and **4**(*c*) illustrate exemplary screen displays for commanding a medical device according to the method of FIG. **4**(*a*);

FIG. **5**(*a*) presents a flow diagram illustrating an exemplary method for recognizing and reporting an alert condition according to medical data logged via the remote monitoring system according to FIG. **1**;

FIG. **5**(*b*) illustrates an exemplary screen display for selecting a recipient for receiving an alert message according to the method of FIG. **5**(*a*); and

FIG. **6** presents a block diagram of an exemplary computer or server device suitable for use in the remote monitoring system according to FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to exemplary embodiments of the invention, including the best modes contemplated by the inventors for carrying out the invention. Examples of these exemplary embodiments are illustrated in the accompanying drawings. While the invention is described in conjunction with these embodiments, it will be understood that it is not intended to limit the invention to the described embodiments. Rather, the invention is also intended to cover alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

In the following description, specific details are set forth in order to provide a thorough understanding of the present invention. The present invention may be practiced without some or all of these specific details. In other instances, well-known aspects have not been described in detail in order not to unnecessarily obscure the present invention.

For the purpose of illustrating the present invention, exemplary embodiments are described with reference to FIGS. **1-6**.

In this specification and the appended claims, the singular forms "a," "an," and "the" include plural references unless the context clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs.

A diagram of an exemplary system **100** for monitoring medical devices in accordance with the present invention is illustrated in FIG. **1**. For example, one or more medical devices **10** are provided at a patient facility **20** for monitoring the medical condition and/or administering medical treatment to one or more patients. Patient facility **20** may comprise a critical care health service center (for example, including hospitals, clinics, assisted living centers and the like) servicing a number of patients, a home facility for servicing one or more patients, or a personal enclosure (for example, a backpack) that may be attached to or worn by an ambulatory patient. Examples of medical devices include,

but are not limited to, include ventilators, urology devices, energy delivery devices, pulse oximeters, predictive thermometers, tympanic thermometers, patient electrodes, and food pumps.

Associated with each medical device **10** is an interface circuit **15** that includes a transceiver having one or more of a transmitter and/or a receiver for respectively transmitting and receiving signals in a facility-oriented wireless network **17** such as, for example, a Low-Rate Wireless Personal Area Networks or "LR-WPAN," ZIGBEE network or another low-power personal area network such as a low power Bluetooth network, existing or presently under development or consideration. See, e.g., Houda Labiod et al., *Wi-Fi, Bluetooth, Zigbee and WiMax*, Springer 2010, which is incorporated by reference herein in its entirety. It should be understood that interface circuit **15** may be contained within or disposed external to medical device **10** in accordance with the present invention.

Also provided within the patient facility **20** are one or more relay modules **30**. Each relay module **30** includes a first transceiver for receiving signals from and transmitting signals to the interface circuits **15** in the facility-oriented wireless network **17**, and further includes a second transceiver for wirelessly transmitting signals to and receiving signals from an access point **40** via a wireless wide-area network ("WWAN") **52**. Suitable WWANs for use with the present invention include, for example, networks based on a Global System for Mobile Communications (GSM) or Code Division Multiple Access (CDMA) cellular network or associated with the 2G, 3G, 3G Long Term Evolution, 4G, WiMAX cellular wireless standards of the International Telecommunication Union Radiocommunication Sector (ITU-R). See, e.g., Vijay Garg, *Wireless Communications & Networking*, Morgan Kaufmann 2007, which is incorporated by reference herein in its entirety. For compliance with HIPAA regulations, communications over each of the facility-oriented wireless network and WWAN are preferably conducted securely using, for example, a Secure Sockets Layer (SSL) protocol or a Transport Layer Security (TLS) protocol or other cryptographic protocols.

As illustrated in FIG. **1**, the access point **40** useable with the present invention includes an inbound server ("device integration server") **41** that incorporates or otherwise has access to a transceiver for communicating with the relay modules **30** over the WWAN. Medical device data, medical device identifier, and/or patient identifier received by the device integration server **41** over the WWAN is forwarded to a secure device web server **42**, which is configured for example to log the received data in association with identification information of the associated medical devices in a device control database **44**. "Medical device data" as generally used herein means data from or about the medical device including, for example, medical device identification, medical device software, medical device settings or status information (including alarm information and/or alarm priority), patient identification information, patient personal identification number(s) "PIN(s)", patient prescriptions, and/or patient medical and/or physiological data as is collected, produced and/or generated by at least one of the medical device and patient identification device; as well as wireless relay network information such as location or status information.

An outbound web server **43** is configured, for example, to receive and qualify data retrieval requests submitted by one or more of first remote monitoring devices **62** over a broad-band network **50** (for example, over the Internet), and/or second remote monitoring devices **70**, **75** over a wired or wireless wide area network. It is advantageous for such requests be made in an encrypted format. Suitable encryption formats useable for such requests may include, for example, formats compliant with the HIPAA regulations described above. For each qualified request, the outbound web server **43** requests associated medical device data or portions thereof to be retrieved from the device control database **44** via the secure device web server **42**, requests associated program data for constructing a display page from a metadata and applications database **46**, and requests associated patient data to be retrieved from a patient database **66** provided in a patient care database node **60** over a secure link **54** via a secure patient web server **64**. The secure link **54** can be implemented, for example as another WWAN using a SSL protocol or a TLS protocol. By separating medical device data and patient data to be respectively stored and managed by access point **40** and patient care database node **60**, certain economies of scale can be achieved by configuring the access point **40** to support a number of different patient care facilities each maintaining its own secure patient care database node **60** to ensure privacy and control of its associated patient data.

In this case, for example, a third party service provider may host the access point **40** to simultaneously support a number of distinct patient and/or home care facilities, thereby eliminating the need for each of these facilities to configure and maintain their own private access point facilities and providing hosting service to each facility that are likely far less than the costs of configuring and maintaining dedicated access point facilities by each care facility provider. It should be noted however that, consistent with principles of the present invention, access point **40** and patient care database node **60** may nevertheless be integrated into a single access point or node (for example, by a provider of a very large-scale facility provider monitoring many hundreds or thousands of patients). In either case, and as further described herein, the outbound web server **43** provides an interface for authenticated clinicians or other monitoring personnel to retrieve patient and medical device data from each of the patient care database node **60** and the access point **40** in a convenient and transparent manner such that the details of the configurations and operation of the access point **40** and patient care database node **60** are of no consequence to the clinicians or other monitoring personnel.

The first remote monitoring devices **62** are intended to be used by healthcare providers such for example, clinicians, physicians, technicians, nurses and other healthcare specialists monitoring patients associated with medical devices **10**. Suitable first remote monitoring devices **62** may include, for example, desktop or laptop computers, tablet computer smart or other mobile phones, or other fixed or portable display devices. The second remote monitoring devices **70**, **75** are advantageously intended to be used by caregivers and/or relatives of the patient such as parents, located proximate the patient such as in a homecare environment or small healthcare facility, or nurses at a larger healthcare facilities, e.g., hospitals. Suitable second remote monitoring devices **70**, **75** likewise may include, for example, desktop or laptop computers, tablet computer, smart or other mobile phones, or other fixed or other portable communication devices.

In addition, the outbound web server **43** is depicted coupled to a network status server **80**, which monitors the status of the facility-oriented wireless network **17** and associated medical devices **10**. The network status server **80** is intended to provide status information concerning the facility-oriented wireless network **17** and associated medical

devices **10** to the outbound web server **43**. Exemplary status information concerning the facility-oriented wireless network **17** includes, for example, signal strength, data rates, particular transmission time stamps between modules comprising the network **17**, number active relay modules in the network **17**, unique identifier number for a particular relay module of the network **17**.

The network status server **80** may be implemented in hardware or software running on an application specific or general purpose processor or computer, as part of or separate from the outbound web server **43**. In addition, the network status server **80** is shown coupled to the outbound web server **43** for ease of illustration and discussion purposes only. The network status server **80** may be coupled to any component or network of the access point **40** or facility-oriented wireless network **17** in accordance with the invention.

In FIG. **1**, upon retrieving the requested medical device data and patient data from the patient care database node **60**, the outbound web server **43** then proceeds to format and transmit the retrieved medical device data and patient data (and/or provide status information concerning the facility-oriented wireless network **17** and associated medical devices **10**) as respective webpages or other formats for display by corresponding first and second remote monitoring devices **62**, **70**, **75** according to the retrieved program data. It is possible for the webpages or other formatted information for display to include the same or differing content and format for the intended remote monitoring device user depending upon the retrieved program data. For example, the detailed medical device data provided to and displayed on a first remote monitoring devices **62** for a clinician may differ from the less detailed information provided to and displayed on a second remote monitoring devices **70** monitored by a parent or visiting nurse or other healthcare professional in a home-care environment. The status information concerning the facility-oriented wireless network **17** and associated medical devices **10** may advantageously be provided to first and/or second remote monitoring devices **62**, **70** and **75** in the same or different encrypted formats as may be deemed appropriate.

In addition, and as will be further described herein, the device integration server **41** of FIG. **1** is configured to transmit information and commands to the relay modules **30**, for example, for transmitting medical device or alert messages to other WWAN-reachable nodes (for example, cellular telephones of emergency attendants), and/or transmitting operating commands and/or software or firmware updates to the medical devices **10** via the interface circuits **15** and facility-oriented wireless network **17**.

Further, in addition to monitoring and sending commands to medical devices, the device integration server **41** may also be configured to receive and analyze patient metric information from the secure patient web server **64** via the outbound web server **43** and secure device web server **42**, or by an alternate and direct secure data link to the secure patient web server **64** in order to prevent unsafe medical device usage based upon the patient metrics information. It is possible for a database (not depicted) accessible, for example, by the device integration server **41** and/or device web server **42**, to store various safe and unsafe operating parameters and conditions for performing such analysis. In this manner, the device integration server **41** would function as an additional failsafe for preventing operating errors that could result in patient harm.

For example, in the case that the patient metric information indicates that an enteral feeding pump is associated with a neonate, the device integration server **41** may act, for example, to (1) discard remote monitoring commands programming large bolus or excessive feeding rates that could be harmful to a young child; and (2) provide a warning message or other notification to the user of the likely unsafe usage condition that may result by implementation of such comment. Alternatively, if the patient metric information indicates that a specific feeding rate or bolus amount has been prescribed by a doctor or clinician, then the device integration server may act to discard remote monitoring commands programming a rate or bolus that deviates from the prescription.

FIG. **2** illustrates a flow diagram of one exemplary method **200** in accordance with the invention for registering medical devices **10** with the system **100** of FIG. **1**. The method **200** begins at step **202**, at which an authorized technician or other personnel having access to one of the remote monitoring devices **62**, **70**, **75** provides authenticating credentials (for example, a recognized log-in and password) to the outbound web server **43**, and the web server responds by transmitting a device set-up screen to the remote monitoring device **62**, **70**, **75** requesting medical device identifying information and associated patient identifying information.

At step **204**, the outbound web server **43** preferably queries the metadata and application database **46** according to one or more of identifying information for the technician and/or identifying information for the patient to identify an associated patient care database node **60** from a plurality of patient care database nodes for the patient and record a destination address for the associated patient care database node **60** in the metadata and application database **46** in association with the identifying data for the medical device **10** and/or identifying information for the patient. Identifying information for the patient is preferably generated anonymously (for example as a random number), and transmitted at step **206** to the patient care database node **60** for association with securely-stored patient identifying information. At step **208** of the method **200** of FIG. **2**, the outbound web server **43** requests that the secure device web server **42** assign an area of the device control database **44** for logging associated medical device data for the medical device **10** as it is received by the device integration server **41**, such that it can be later retrieved by the outbound web server **43** upon receiving an authorized request from an authenticated user operating one of the remote monitoring devices **62**, **70**, **75**.

It should be readily understood by one skilled in the art that step **204** of method **200** for identifying and storing the address of the patient care database node **60** may be omitted in accordance with the invention if a single patient care database node is utilized with system **100** of FIG. **1**.

FIG. **3**(*a*) presents a flow diagram illustrating one exemplary method **300** in accordance with the invention for retrieving and viewing medical device data on a remote monitoring device **62**, **70**, **75** for a registered medical device **10** according to the system of FIG. **1**. The method **300** begins at step **302** with a first authorized user having access to one of the first remote monitoring devices **62** provides authenticating credentials (for example, a recognized log-in and password) to the outbound web server **43**. In addition, in step **302**, a second authorized user having access to one of the second remote monitoring devices **70**, **75** likewise provides respective authenticating credentials to the outbound web server **43**

At step **304**, based on verification of the authenticating credentials of the first and second authorized users, the outbound web server **43** queries the metadata and applica-

tions database **46** to identify the address of patient care database node(s) **60** to which the respective first and second authorized users are entitled to obtain access, and at step **306**, requests data from the patient care database node **60** relating to at least one identified patient for which the first and second user are respectively authorized to view medical device data, including for example a listing of medical devices **10** which are presently associated with the identified patient, and/or status information of the facility-oriented network **17**. It should be readily understood that different authenticated users will likely have different levels of sophistication and skill for which a corresponding access level may be associated with their authentication account or status which may further be used, for example, to limit or expand the type and/or extent of medical device data that may be transmitted to the remote monitoring devices for such authenticated users.

At step **308** of the method **300** of FIG. **3**(*a*), the outbound web server **43** queries the device control database **44** via the secure device web server **42** for status information to determine which of the listed medical devices are presently active according to the data logged by the device control database **44**. It should be noted that one or more of a medical device **10**, its associated interface device **15**, an associated wireless relay module **30** and/or the device integration server **41** may be programmed to provide data from the medical device **10** to the device integration server **41** at predetermined, preset intervals or otherwise, which can then be provided to server **43** in response to inquiries therefrom.

Upon obtaining the status information, the outbound web server **43** prepares respective display pages with encrypted medical device data, according for example to display information retrieved from the metadata and applications database **46**, to display listings of medical devices **10** available for monitoring by respective authorized users at the remote monitoring devices **62**, **70**, **75**. FIG. **3**(*b*) presents a first exemplary screen display **320** to the remote monitoring devices **62**, **70**, **75** that provides an array of medical devices **10** available for monitoring according to device type. For example, in the screen display **320** of FIG. **3**(*b*), available device types include ventilators **321**, urology devices **322**, energy delivery devices **323**, pulse oximeters **324**, predictive thermometers **325**, tympanic thermometers **326** and food pumps **327**. Each of the device types **321-327** in FIG. **3**(*b*) is presented with an identifying label (for example, label **321**A) and an identifying image (for example, image **321**B) for ease of recognition.

Once a device type is selected by a user (for example, in response to an associated mouse-over or mouse-click executed by the authorized user), a second exemplary screen display **330** as illustrated by FIG. **3**(*c*) may preferably be transmitted by the outbound web server **43** for display at the remote monitoring devices **62**, **70** or **75**. In the display **330**, labels **337**A are provided in association with images **337**B in order to identify individual food pumps (for example, by patient and/or by logical or physical location). Medical devices **10** that are unavailable may for example preferably be depicted with a label **337**A' ("Off Line") and an image **337**B' (depicting the device with a slash or cross applied over the image or shaded or shadowed) that distinguish the unavailable medical devices **10** from available medical devices **10**.

Once an individual device is selected by the first or second user (for example, once again, in response to an associated mouse-over or mouse-click executed by the authorized user), a third exemplary screen display **340** as illustrated by FIG. **3**(*d*) may preferably transmitted by the outbound web server **43** for display at the corresponding remote monitoring device **62**, **70**, **75**. In the display **340**, for example, device information of the medical device **10** (in this case, a food pump) is displayed in a screen **347**A preferably recreating a current screen generated and displayed by the medical device **10**. In addition, the screen display **340** includes any of a panel **347**B providing identifying information for the medical device **10** (in this case, a pump location), a panel **347**C for displaying a message indicating a current error condition of the pump, and an icon button **347**D for selecting an alternate "status" mode of the screen display **340**. The screen display **340** also includes a control icon button **347**E for selecting a system set-up screen display, and a control icon button **347**F for enabling device control from the remote monitoring device **62**. For example, upon selecting the control icon **347**F, the screen display **340** may preferably be refreshed to include the medical devices screen **347**A and one or more operable buttons that mimic the appearance of control buttons on the medical device. The control button features are described in greater detail below in relation to FIGS. **4**(*b*) and **4**(*c*).

It should be readily understood that exemplary computer screen images **320**, **330** and **340** and corresponding navigation depicted by FIGS. **3**(*b*), **3**(*c*) and **3**(*d*) are for illustration purposes only and that many other user screen images displays and interface tools may be utilized for carrying out the present invention including, for example, computer screens that depict accessible medical devices by other means than device type as illustrated in FIG. **3**(*b*). For example, as a suitable alternative to the screen image **340** of FIG. **3**(*d*) that conveys information from a single medical device, it is possible to implement displays that provide information from multiple medical devices. In addition, it should be readily understood that the outbound web server **43** will preferably be operable to prepare display pages with encrypted medical device data for display on any of a wide variety of display devices (including, for example, workstations, personal computers, tablet devices including tablet computers, and display-based mobile devices including personal digital assistants, smartphones, portable game systems and the like.

It should also be readily understood that the computer screen images to be available to first and second users of the first and second remote monitoring devices may be different depending upon whether such user is a clinician, nurse, patient relative or other caregiver, i.e., dependent on level of entitlement of the particular authorized user. For example, a display for a clinician at a first remote monitoring device **62** may enable the clinician to adjust the settings of a subject medical device **10**, in contrast to a display for a second remote monitoring device **70**, **75** used by a patient relative, which depicts only fundamental information from the medical device data with no option for the patient relative to adjust the medical device settings via the second remote monitoring device **70**, **75**. Likewise, different encryption methods or formats may be employed for medical device data transmitted to the first remote monitoring device **62** than the second remote monitoring device **70**, **75**.

FIG. **4**(*a*) presents a flow diagram illustrating an exemplary method **400** in accordance with the invention for issuing a command to a medical device **10** via the system **100** according to FIG. **1**. The method **400** begins at step **402** with an authorized user adjusts an operating parameter, such as a clinician (also referred to as a "authorized clinician" or "user" herein) logging into the outbound web server **43** using a first remote monitoring device **62** and navigating to the device screen display **340** of FIG. **3**(*d*) (for example, as

described above with reference to FIGS. **3**(*a*)-**3**(*d*)). At step **404**, the clinician proceeds to select the "Enable Full Control" button **347**F of FIG. **3**(*d*) to initiate an operational command directed to the medical device **10**, and is preferably provided with a request for authentication pertaining in particular to the patient associated with the medical device **10**. At step **406**, patient authentication information provided by the clinician is forwarded by the outbound web server **43** to a patient care database node **60** according to a patient care database node address stored by the metadata and applications database **46** in association with the clinician, and the clinician is authenticated for the patient by the outbound web server **43** upon receipt of an authentication confirmed message from the patient care database node **60**.

Upon receipt of the patient authentication, a control request is forwarded by the outbound web server **43** at step **408** to the secure device web server **42** to be logged in the information record of the device control database **44** that is associated with the medical device **10** (and optionally, with an anonymous ID for the patient). At step **410**, the secure device web server forwards the control request, such as an encrypted control request, to the device integration server **41**, which transmits an associated device control command over the secure WWAN **52** for receipt by an associated wireless relay module **30** at step **412**. The wireless relay module **30** wirelessly communicates the command to the medical device **10** via an associated device interface **15**, and awaits a reply confirming execution of the command transmitted by the device interface **15**.

At step **414**, the device integration server **41** receives an update message from the wireless relay module **30** via the secure WWAN **52** which confirms that the command was executed by the medical device **10**. At step **416**, the device integration server **41** forwards the update message to the secure device web server **42** to be logged in the information record of the device control database **44** that is associated with the medical device **10**. Optionally, and preferably, the secure device web server **42** forwards information pertaining to the update message to the outbound web server **43**, and the outbound web server **43** prepares an updated display screen that is securely transmitted to the remote monitoring device **62** to indicate that the command has been executed.

Alternatively, at step **404**, the authenticated clinician may select the "System Setup" control icon button **347**E to perform a command other than an operational command directed to the medical device **10**. FIG. **4**(*b*) illustrates a display screen **450** that is presented to the clinician upon selecting the control icon button **347**E. The display screen **450** includes a number of icon buttons that may be selected by the clinician (for example, as the result of a mouse-over or mouse-click initiated by the clinician) to select a specific setup command. For example, icon button **451** may be selected to initiate a command for providing identification information of the medical device **10**. Icon button **452** may be selected to provide text paging in response to an alert condition, as is further described herein. Icon button **453** may be selected to initiate a software or firmware download for updating the medical device **10**.

Icon button **454** may be selected to initiate a diagnostic test of the medical device **10**. FIG. **4**(*c*) illustrates an exemplary display screen **460** that may be displayed to the clinician upon selection of the icon button **454**. Via the display screen **460** of FIG. **4**(C), the clinician may select one or more of (including a progression of) a series of diagnostic tests **461** directed to components of the medical device (for example, including power components, memory components, alarm components and the like). Alternatively and/or in addition, the clinician may select one or more of a series of performance statistics **462** to be gathered and displayed (for example, including various device error statistics such as feed error, rotor error and flush error rates for a food pump). In addition, perhaps most usefully before issuing a software and/or firmware download command, the clinician may select a version number test **463** to obtain version identifying information for the software and/or firmware (preferably including, for example, a software and/or firmware download history). Optionally, processes for performing the diagnostic tests **461**, preparing the performance statistics **462** and identifying the software and/or firmware version number **463** may run automatically without specifically being selected by the clinician, with a complete reporting of all results on the display screen.

In a similar manner to that performed by the method of FIG. **4**(*a*), it is possible to issue a bandwidth priority command or instruction to a relay module, such as relay module **30** of FIG. **1**, for the relay module to grant priority for relaying information received from a particular medical device relative to other medical devices that may send or receive communications via this relay module. For example, it would be advantageous to provide greater bandwidth priority to a critical care device such as a ventilator supporting the breathing function of a patient relative to a weight scale or thermometer. It is also possible to a number of bandwidth priority levels assignable to respective medical devices based upon, for example, the critical nature of the data or function provided by such devices.

Referring again to FIG. **4**(*b*), icon button **455** may be selected to enable the clinician to specify data transfer rates, priorities and other parameters relating to the wireless transceiver of the interface device associated with the medical device. Icon button **456** may be selected to provide the clinician with the an alarm history, event history and other information as has been logged for example for the medical device in the device control database **44** of FIG. **1**.

It should be readily understood that the method **400** for remotely issuing a command to a medical device **10** was described with respect to a user of a first remote monitoring device **62** and not a user of the second remote monitoring **70**, **75** because as described for example throughout this application, it is assumed that the user of the first remote monitoring device **62** is a clinician, technician or other highly-skilled healthcare professionals, while the user of the second remote monitoring device **70**, **75** may be a patient relative or caregiver of lesser skill. Nevertheless, the method **400** is likewise useable to enable a user of the second monitoring device **70**, **75** to also control particular settings of the medical device **10**.

FIG. **5**(*a*) presents a flow diagram illustrating one exemplary method **500** in accordance with the invention for recognizing and reporting an alert condition according to medical device data (including the status of the facility-oriented network **17**) logged via the system **100** according to FIG. **1**. The method **500** begins at step **502** with the transmission of an alert message by a wireless relay module **30** over the secure WAN **52** to the device integration server **41**. In this case, the wireless relay module **30** is configured to analyze (such as by detecting flag or status information or comparing message data to information stored in an associated database) a message type of a message transmitted by an associated medical device **10** to determine that the message is an alert message, and to transmit the message to the device integration server **41** upon determining that the message is an alert message (for example, as a priority message). Alternatively, the wireless relay module **30** may

simply queue all messages for transmission to the device integration server **41** in order upon receipt, and rely upon the device integration server **41** to analyze an associated message type to determine that a message is an alert message.

Upon determining that the transmitted message is an alert message, the device integration server **41** proceed, at step **503**, to log the message in the device control database **44**, and at step **504**, invokes a text messaging application that retrieves text messaging numbers associated with identifying information of the medical device **10** and/or anonymous patient identifying information. The determination of whether the transmitted message is an alert message may be carried out by, for example, detecting an alert flag or trigger identifier in the message or scanning the message for other information indicative of an alert condition. The text messaging application may preferably retrieve the text messaging numbers by querying the metadata and applications database **46** to identify the address of an associated patient care database node **60**, and either making a direct request or instructing the outbound web server **43** to request the text messaging numbers from the associated patient care database node **60**.

At step **506**, the device integration server **41** sends one or more messages including the retrieved text messaging numbers and text message information according to the alert message to one or more wireless relay modules **30** over the secure WWAN **52**. At step **508**, the one or more wireless relay modules **30** transmit the text message information addressed to the text messaging numbers over one or more of the secure WWAN **52** and/or the facility-oriented wireless network **17** to complete the method **500**.

FIG. **5**(*b*) illustrates a "Text Paging" **452** screen display **550** that may be invoked, for example, by using the method **400** of FIG. **4**(*a*) for issuing a command to a medical device **10**. Specifically, and with particular reference to FIGS. **3**(*d*) and **4**(*b*), the text paging screen **550** is displayed at the first remote monitoring device **62** of an authenticated clinician upon the clinician's selection of the "System Setup" icon button **347***e* of the screen display **340**, and thereafter upon the clinician's selection go the "Text Paging" icon button of the screen display **450**. Likewise, it is possible for the paging screen **550** of FIG. **5**(*b*) to be displayed on a second remote monitoring device **70**, **75** for completion by an authorized user, such as a patient relative or other caregiver. As illustrated in FIG. **5**(*b*), the "Text Paging" screen display **550** include a listing of one or more names **551** of individuals responsible for responding to alert messages of at least two types: "Error Messages" **553**, which may for example indicate a malfunction of the medical device **10**, and/or "Info Messages" **554**, which may for example indicate a significant patient health condition (for example, a patient respiration rate below a preset minimum rate specified for a ventilator device **321** of FIG. **3**(*b*)).

The information retrieved by the outbound web server **43** to prepare this display is preferable retrieved from the patient care database node **60**, by providing on one or more of identifying information for the medical device **10** and/or anonymous patient identifying information stored in the device control database **44**. Upon recognizing an alert message for the medical device **10**, the information provided on the "Text Paging" screen display may be retrieved by the device integration server **41** by querying the metadata and applications server **46** to retrieve address information for the patient care database node **60**, and forwarding a text paging information request to the patient care database node **60** based upon one or more of identifying information for the medical device **10** and/or anonymous patient identifying information stored in the device control database **44**. The recognition of whether the received message from the medical device **10** is an alert message may be carried out by, for example, detecting an alert flag or trigger identifier in the message or scanning the message for other information indicative of an alert condition.

It should be readily understood that the use of communicating alert messages using text messaging in FIGS. **5**(*a*) and **5**(*b*) is for ease of illustration purposes only and that such alerts may be communicated in other ways in accordance with the present invention including email, audio messages via telephone calls, as well as any other wired and/or wireless text, audio, or multimedia based communication services receivable by, for example, by a smart phone or computer tablet software application or "App."

FIG. **6** shows an illustrative computer system **600** suitable for implementing server and computer components of the present invention (for example, including device integration server **41**, secure device web server **42**, outbound web server **43**, and secure patient web server **64**). The computer system **600** as described herein may comprise, for example, a personal computer running the WINDOWS operating system, or a server computer running, WINDOWS Server, LINUX or another UNIX-based operating system. Alternatively, the computer system **600** described herein may comprise a mobile device, tablet devices or computers, or information appliance running, for example, an operating system in the group including Symbian, Android, Apple iOS, Blackberry, Microsoft Windows Phone, Linux, Palm/HP WebOS, BADA, MAEMO and MEEGO. The above-described methods carried out by the server and computer components of the present invention may be implemented on the computer system **600** as stored program control instructions directed to control application software.

Computer system **600** includes processor **610**, memory **620**, storage device **630** and input/output devices **640**. One of the input/output devices **640** may preferably include a display **645**. Some or all of the components **610**, **620**, **630** and **640** may be interconnected by a system bus **650**. Processor **610** may be single or multi-threaded, and may have one or more cores. Processor **610** executes instructions which in the disclosed embodiments of the present invention are the steps described, for example, in one or more of FIG. **2**, **3**(*a*), **4**(*a*) or **5**(*a*). These instructions may be stored in one or more of memory **620** or in storage device **630**. Information may be received and output using one or input/output devices **640**. Memory **620** may store information and may comprise a computer-readable medium, such as volatile or non-volatile memory. Storage device **630** may provide storage for system **600** including for the example, the previously described database, and may be a computer-readable medium. In various aspects, storage device **630** may be one or more of a flash memory device, a floppy disk drive, a hard disk device, and optical disk device, and/or a tape device.

Input devices **640** may provide input/output operations for system **600**. Input/output devices **640** may include one or more of a keyboard, a pointing device, and/or microphone. Input/output devices **640** may further include a display unit for displaying graphical user interfaces, a speaker and a printer and any of a number of other serial devices (for example, configured as Universal Serial Bus (USB)-based devices

It should of course, be understood that while the present invention has been described with respect to disclosed embodiments, numerous variations are possible without departing from the spirit and scope of the present invention as defined in the claims.

Moreover, it is intended that the scope of the present invention include all other foreseeable equivalents to the elements and structures as described herein and with reference to the drawing figures. Accordingly, the invention is to be limited only by the scope of the claims and their equivalents.

We claim:

1. A system for enabling remote monitoring of a plurality of medical devices, the system comprising:

two or more wireless relay modules forming a wireless relay network, each of the two or more wireless relay modules having a first transceiver configured to receive signals from and transmit signals to at least two of the plurality of medical devices in communication with the wireless relay network, and a second transceiver configured to be in communication with an internet-accessible wireless network, each medical device configured to communicate with one or more of the wireless relay modules;

a database configured to have stored therein a set of safe operating parameters for the plurality of medical devices, a set of unsafe operating parameters for the plurality of medical devices, and a set of conditions for the plurality of medical devices for determining whether a command sent to one of the medical devices is an unsafe command;

a device integration server in communication with the two or more wireless relay modules, wherein said two or more wireless relay modules are configured to transmit data packets containing information provided by any of the plurality of medical devices, wherein each of said data packets includes medical device data and at least a medical device identifier or a patient identifier, and wherein said device integration server is configured to monitor commands sent to the medical devices to prevent unsafe medical device usage by accessing the database to evaluate the safe and unsafe operating parameters for a medical device, and the conditions for determining whether a command sent to at least one of the plurality of medical devices is an unsafe command;

a data manager system coupled to said device integration server, said data manager system comprising at least a device control database; and

a web server configured for providing web pages for receiving at least the medical device data, formatting the medical device data as first medical device data based upon a type of user authenticated on a first remote monitoring device, and transmitting the first medical device data to the first remote monitoring device via a secure internet connection for displaying the first medical device data at the first remote monitoring device and formatting the medical device data as second medical device data based upon a second type of user authenticated on a second remote monitoring device, and transmitting the second medical device data to the second remote monitoring device for displaying the second medical device data at the second remote monitoring device.

2. The system of claim **1** wherein the web server is configured for verifying one or more of the patient identifier or the medical device identifier before transmitting the first medical device data to the first remote monitoring device.

3. The system of claim **1** wherein said web server is configured to transmit the second medical device data to the second remote monitoring device by at least a wireless data link.

4. The system of claim **3** wherein said wireless data link is over a wireless mobile data network.

5. The system of claim **1** wherein the second remote monitoring device is a portable communications device of least one of a mobile phone, tablet computer and portable computer.

6. The system of claim **1** wherein said web server is configured to transmit to at least one of the first and the second remote monitoring devices, status information concerning the wireless relay network.

7. The system of claim **1** wherein the second remote monitoring device is located in a same facility as a patient for use by a local caregiver.

8. The system of claim **1** wherein the first medical device data displayed by the first remote monitoring device and the second medical device data displayed by the second remote monitoring device are different.

9. The system of claim **8** wherein the first medical device data displayed by the first remote monitoring device includes data for use by a clinician and the second medical device data displayed on the second remote monitoring device includes data for use by a caregiver.

10. The system of claim **1** wherein, if a first authenticated user is a clinician, the first medical device data is formatted to include controls to allow the clinician to adjust settings of the at least one medical device.

11. The system of claim **10** wherein, if the first authenticated user is not a clinician, the first medical device data is formatted to exclude controls to allow the authenticated user to adjust the settings of the at least one medical device.

12. The system of claim **1** wherein the second remote monitoring device includes a function for sending messages to and/or paging a clinician.

13. The system of claim **1** wherein the device integration server is configured to discard a command associated with unsafe medical device usage prior to the command reaching the medical device and/or provide a notification of an unsafe condition in response to monitoring the commands.

14. The system of claim **1** wherein the device control database includes a list of medical devices that are presently active.

15. The system of claim **14** wherein the plurality of medical devices are programmed to provide data to the integration server at predetermined intervals.

16. A system for enabling remote monitoring of a plurality of medical devices, the system comprising:

two or more wireless relay modules forming a wireless relay network, each of the two or more wireless relay modules having a first transceiver configured to receive signals from and transmit signals to at least two of the plurality of medical devices in communication with the wireless relay network, and a second transceiver configured to be in communication with an internet-accessible wireless network, each medical device configured to communicate with one or more of the wireless relay modules;

a database configured to have stored therein a set of safe operating parameters for the plurality of medical devices, a set of unsafe operating parameters for the plurality of medical devices, and a set of conditions for the plurality of medical devices for determining whether a command sent to one of the medical devices is an unsafe command;

a device integration server in communication with the two or more wireless relay devices, wherein said two or more wireless relay devices are configured to transmit data packets containing information provided by the

plurality of medical devices including medical device data and at least one of medical device identifier and a patient identifier, and wherein said device integration server is configured to monitor commands sent to the plurality of medical devices to prevent unsafe medical device usage by accessing the database to evaluate the safe and unsafe operating parameters for a medical device, and the conditions for determining whether a command sent to at least one of the plurality of medical devices is an unsafe command;

a data manager system coupled to said device integration server, said data manager system comprising: a device control database;

a web server configured for:

providing web pages for receiving at least the medical device data;

formatting the medical device data as first medical device data based upon a type of user authenticated on a first remote monitoring device;

formatting the medical device data as second medical device data based upon a type of user authenticated on a second remote monitoring device; and,

subject to verification of the patient identifier and/or the medical device identifier, transmitting the medical device data to first and second remote monitoring devices via a secure internet connection for displaying the medical device data at the first and second remote monitoring devices; and

a network status server configured for transmitting to at least one of the first or second remote monitoring devices, status information concerning the wireless relay network associated with the at least two wireless relay devices.

17. The system of claim **16** wherein said network status server is located at a different geographic location than the web server.

18. A system for enabling remote monitoring a plurality of medical devices, the system comprising:

two or more wireless relay modules forming a wireless relay network, each of the two or more wireless relay modules having a first transceiver configured to receive signals from and transmit signals to at least two of the plurality of medical devices in communication with the wireless relay network, and a second transceiver configured to be in communication with an internet-accessible wireless network, each medical device configured to communicate with one or more of the wireless relay modules;

a database configured to have stored therein a set of safe operating parameters for the plurality of medical devices, a set of unsafe operating parameters for the plurality of medical devices, and a set of conditions for the plurality of medical devices for determining whether a command sent to one of the medical devices is an unsafe command;

a device integration server in communication with the two or more wireless relay modules, wherein said two or more wireless relay devices are configured to transmit data packets containing information provided by the plurality of medical devices, wherein each of said data packets includes medical device data and at least a medical device identifier or a patient identifier, and wherein said device integration server is configured to monitor commands sent to the plurality of medical devices to prevent unsafe medical device usage by accessing the database to evaluate the safe and unsafe operating parameters for a medical device and conditions for determining whether a command sent to at least one of the plurality of medical devices is an unsafe command;

a data manager system coupled to said device integration server, said data manager system comprising at least a device control database, and

a web server configured for providing web pages for receiving at least the medical device data and transmitting the medical device data to a first remote monitoring device via a secure internet connection for displaying the medical device data at the first remote monitoring device; and transmitting at least a portion of the medical device data to a second remote monitoring device for displaying the portion of the medical device data at the second remote monitoring device.

19. The system of claim **18** wherein the web server is configured for formatting the medical device data as first medical device data based upon a type of user authenticated on a first remote monitoring device and transmitting the first medical device data to the first remote monitoring device for displaying the first medical device data at the first remote monitoring device.

20. The system of claim **19** wherein the web server is configured for formatting the medical device data as second medical device data based upon a second type of user authenticated on a second remote monitoring device, and transmitting the second medical device data to the second remote monitoring device for displaying the second medical device data at the second remote monitoring device.

21. The system of claim **18** wherein the device integration server is further configured to determine whether a particular command of the commands sent to the at least one of the plurality of medical devices is an unsafe command based on the safe operating parameters, the unsafe operating parameters, and/or the conditions.

22. The system of claim **21** wherein the device integration server is further configured, upon determination that the particular command is an unsafe command, to discard the unsafe command.

23. The system of claim **18** wherein the device integration is further configured, upon determination that the particular command is an unsafe command, to provide a warning message.

24. The system of claim **18** wherein the device integration server is further configured, upon determination that the particular command is an unsafe command, to program the medical device with information that deviates from the particular command.

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