US009730621B2

(12) **United States Patent**
Cohen et al.

(10) **Patent No.: US 9,730,621 B2**
(45) **Date of Patent: Aug. 15, 2017**

(54) **REMOTE MONITORING OF ANALYTE MEASUREMENTS**

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(73) Assignee: **DexCom, Inc.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/142,608**

(22) Filed: **Dec. 27, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 14/142,365, filed on Dec. 27, 2013, which is a continuation-in-part of (Continued)

(51) **Int. Cl.**

A61B 5/00	(2006.01)
A61B 5/145	(2006.01)
G06F 19/00	(2011.01)

(52) **U.S. Cl.**

CPC ..... ***A61B 5/14532*** (2013.01); ***A61B 5/0004*** (2013.01); ***A61B 5/0015*** (2013.01); (Continued)

(58) **Field of Classification Search**

CPC ..... G06F 19/30; G06F 19/32; G06F 19/34; G06F 19/3406; G06F 19/3418; (Continued)

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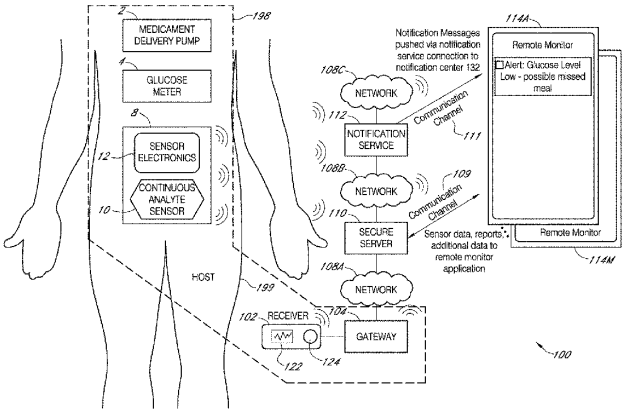
Assistant Examiner — Franklin Balseca
(74) *Attorney, Agent, or Firm* — Knobbe Martens Olson & Bear, LLP

(57) **ABSTRACT**

Methods and apparatus, including computer program products, are provided for remote monitoring. In some example implementations, there is provided a method. The method may include receiving, at a remote monitor, a notification message representative of an event detected, by a server, from analyte sensor data obtained from a receiver monitoring an analyte state of a host; presenting, at the remote monitor, the notification message to activate the remote monitor, wherein the remote monitor is configured by the server to receive the notification message to augment the receiver monitoring of the analyte state of the host; accessing, by the remote monitor, the server, in response to the presenting of the notification message; and receiving, in response to the accessing, information including at least the analyte sensor data. Related systems, methods, and articles of manufacture are also disclosed.

14 Claims, 26 Drawing Sheets



Related U.S. Application Data

application No. 13/843,382, filed on Mar. 15, 2013, which is a continuation of application No. 13/842,679, filed on Mar. 15, 2013.

(60) Provisional application No. 61/747,717, filed on Dec. 31, 2012.

(52) **U.S. Cl.**
CPC ***A61B 5/0022*** (2013.01); ***A61B 5/743*** (2013.01); ***G06F 19/3418*** (2013.01); *A61B 5/0002* (2013.01); *A61B 5/742* (2013.01); *A61B 5/746* (2013.01); *A61B 5/7465* (2013.01); *G06F 19/30* (2013.01); *G06F 19/32* (2013.01); *G06F 19/3406* (2013.01); *G06F 19/3487* (2013.01)

(58) **Field of Classification Search**
CPC G06F 19/3487; A61B 5/74; A61B 5/7405; A61B 5/741; A61B 5/0002; A61B 5/0004; A61B 5/0015; A61B 5/0022; A61B 5/0024; A61B 5/02; A61B 5/742; A61B 5/743; A61B 5/7435; A61B 5/746; A61B 5/7465; A61B 5/14532
USPC 340/870.01, 870.02, 870.07; 705/2, 3; 600/300, 301, 316, 365, 421, 522; 607/28, 30
See application file for complete search history.

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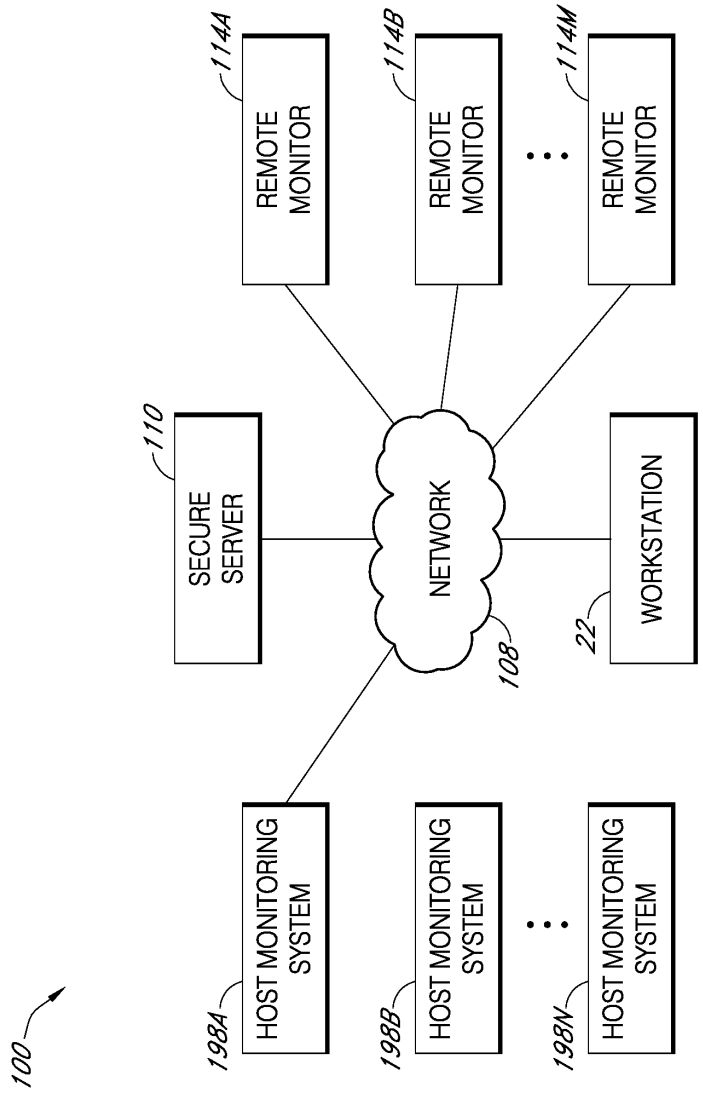
100
110
SECURE SERVER
114A
REMOTE MONITOR
114B
REMOTE MONITOR
114M
REMOTE MONITOR
NETWORK
108
22
WORKSTATION
198A
HOST MONITORING SYSTEM
198B
HOST MONITORING SYSTEM
198N
HOST MONITORING SYSTEM

FIG. 1

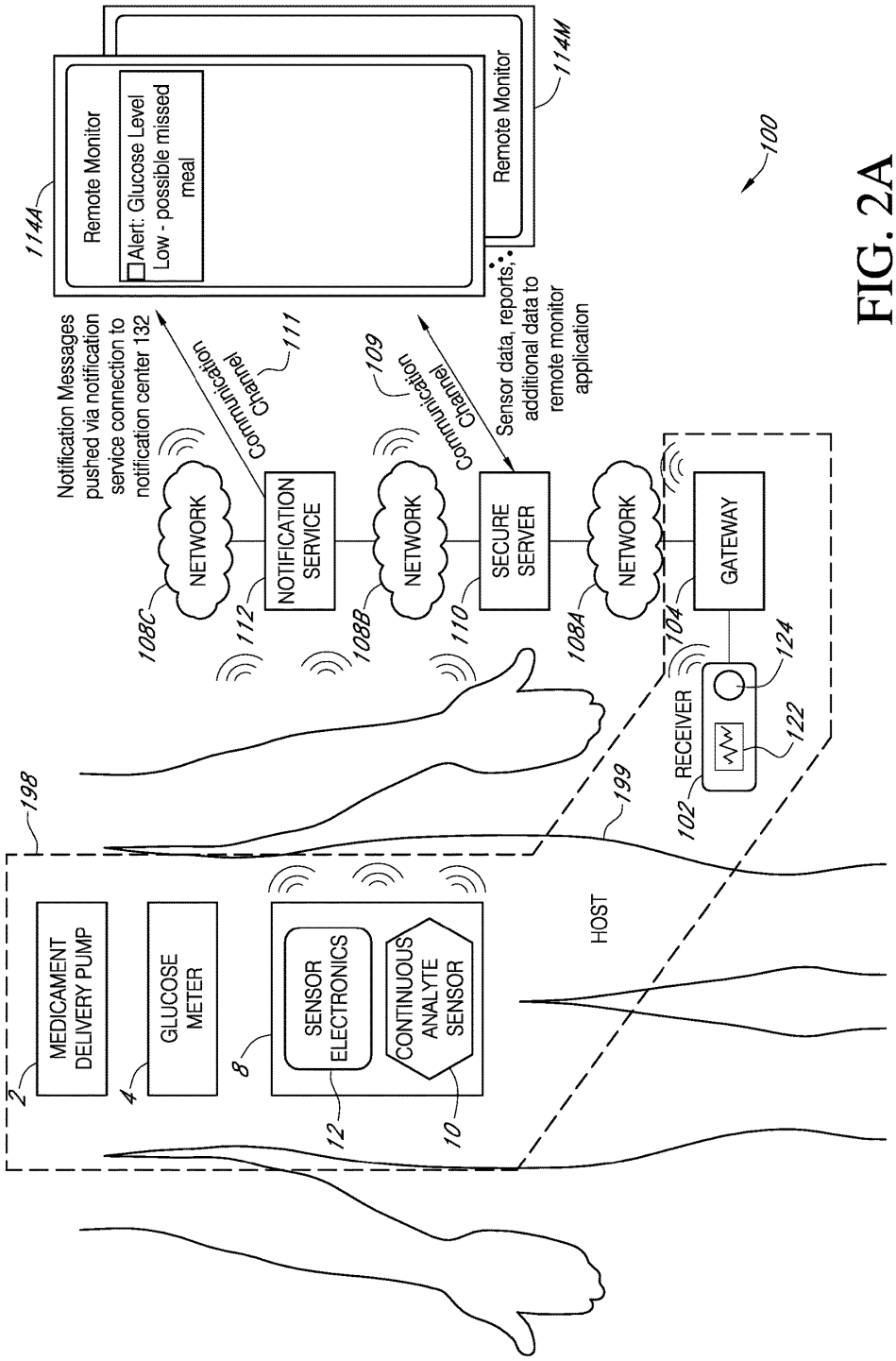
Remote Monitor
Alert: Glucose Level Low - possible missed meal
114A
Remote Monitor
114M
Notification Messages pushed via notification service connection to notification center 132
Communication Channel
111
109
Communication Channel
Sensor data, reports, additional data to remote monitor application
NETWORK
108C
NOTIFICATION SERVICE
112
NETWORK
108B
SECURE SERVER
110
NETWORK
108A
GATEWAY
104
RECEIVER
102
122
124
100
198
199
MEDICAMENT DELIVERY PUMP
2
GLUCOSE METER
4
SENSOR ELECTRONICS
12
CONTINUOUS ANALYTE SENSOR
10
8
HOST

FIG. 2A

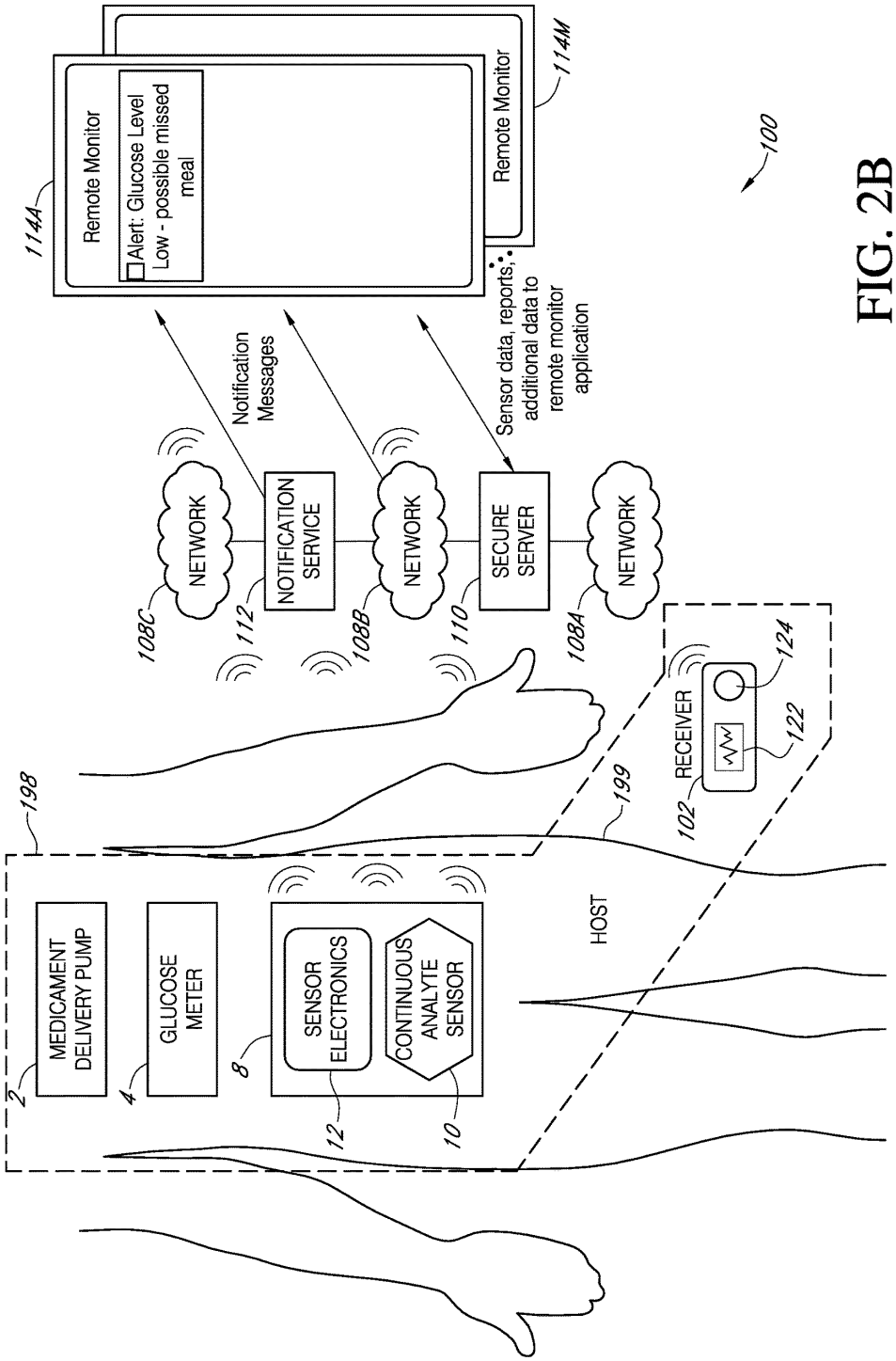
Remote Monitor
Alert: Glucose Level Low - possible missed meal
114A
Remote Monitor
114M
Notification Messages
Sensor data, reports, additional data to remote monitor application
NETWORK
108C
NOTIFICATION SERVICE
112
NETWORK
108B
SECURE SERVER
110
NETWORK
108A
100
198
MEDICAMENT DELIVERY PUMP
2
GLUCOSE METER
4
8
SENSOR ELECTRONICS
12
CONTINUOUS ANALYTE SENSOR
10
HOST
199
RECEIVER
102
122
124

FIG. 2B

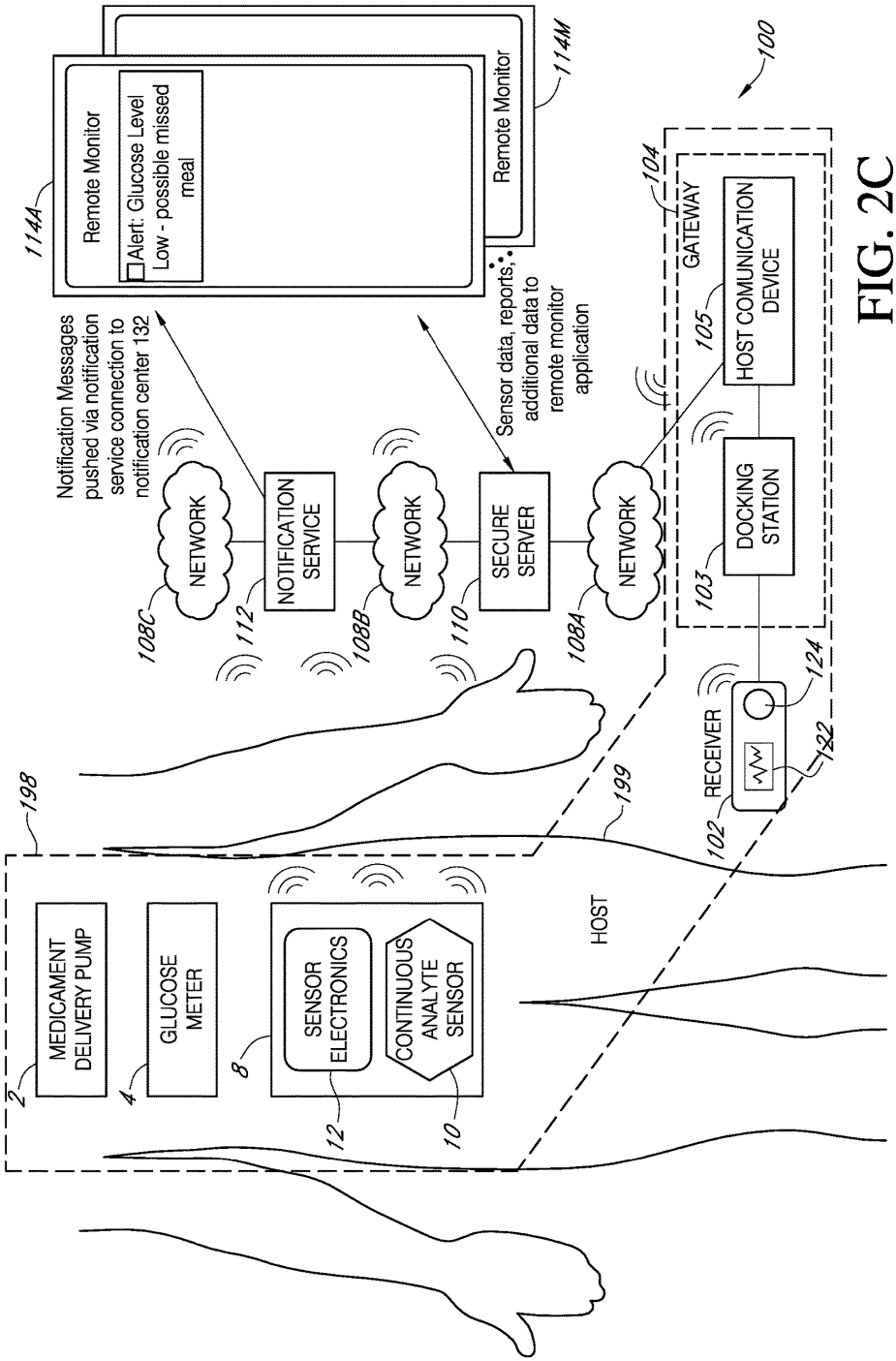
Remote Monitor
Alert: Glucose Level Low - possible missed meal
114A
Remote Monitor
114M
Notification Messages pushed via notification service connection to notification center 132
Sensor data, reports, additional data to remote monitor application
NETWORK
108C
NOTIFICATION SERVICE
112
NETWORK
108B
SECURE SERVER
110
NETWORK
108A
GATEWAY
104
HOST COMUNICATION DEVICE
105
DOCKING STATION
103
RECEIVER
102
124
122
100
198
199
MEDICAMENT DELIVERY PUMP
2
GLUCOSE METER
4
SENSOR ELECTRONICS
12
CONTINUOUS ANALYTE SENSOR
10
8
HOST

FIG. 2C

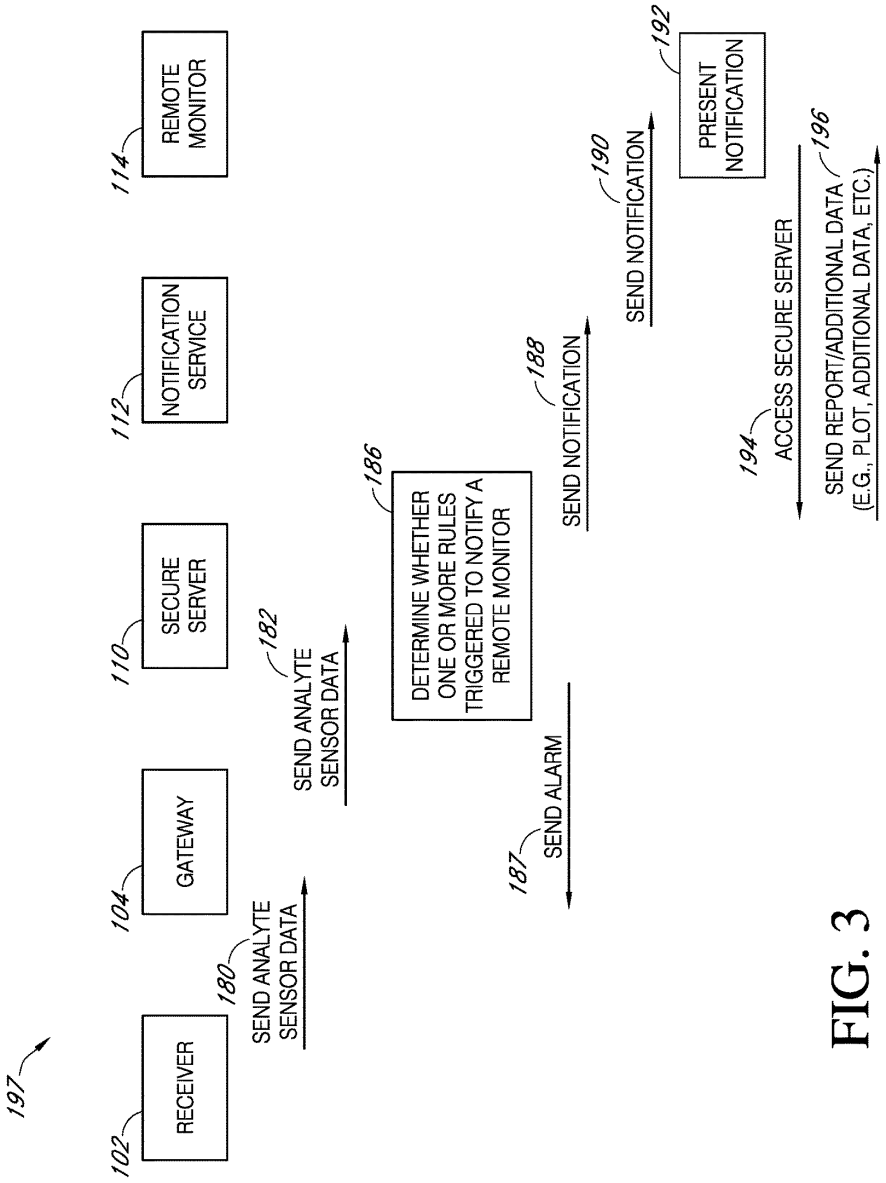
197
102
RECEIVER
104
GATEWAY
110
SECURE SERVER
112
NOTIFICATION SERVICE
114
REMOTE MONITOR
180
SEND ANALYTE SENSOR DATA
182
SEND ANALYTE SENSOR DATA
186
DETERMINE WHETHER ONE OR MORE RULES TRIGGERED TO NOTIFY A REMOTE MONITOR
187
SEND ALARM
188
SEND NOTIFICATION
190
SEND NOTIFICATION
192
PRESENT NOTIFICATION
194
ACCESS SECURE SERVER
196
SEND REPORT/ADDITIONAL DATA (E.G., PLOT, ADDITIONAL DATA, ETC.)

FIG. 3

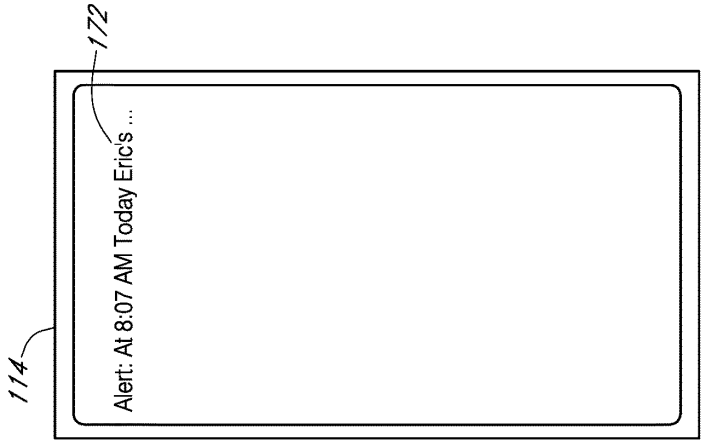
114
172
Alert: At 8:07 AM Today Eric's ...

FIG. 4B

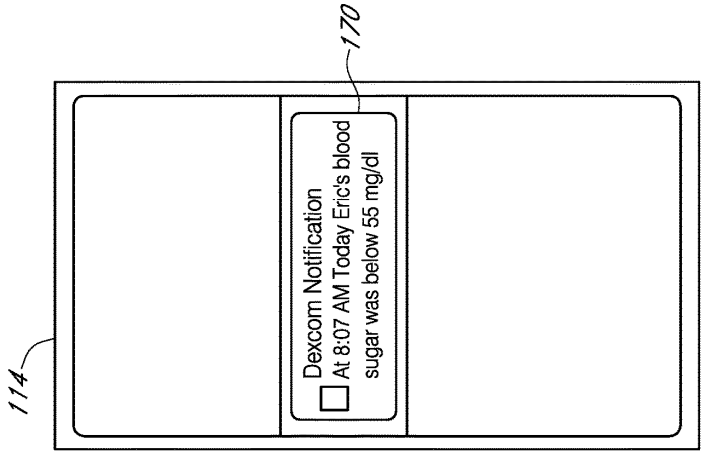
114
170
Dexcom Notification
At 8:07 AM Today Eric's blood sugar was below 55 mg/dl

FIG. 4A

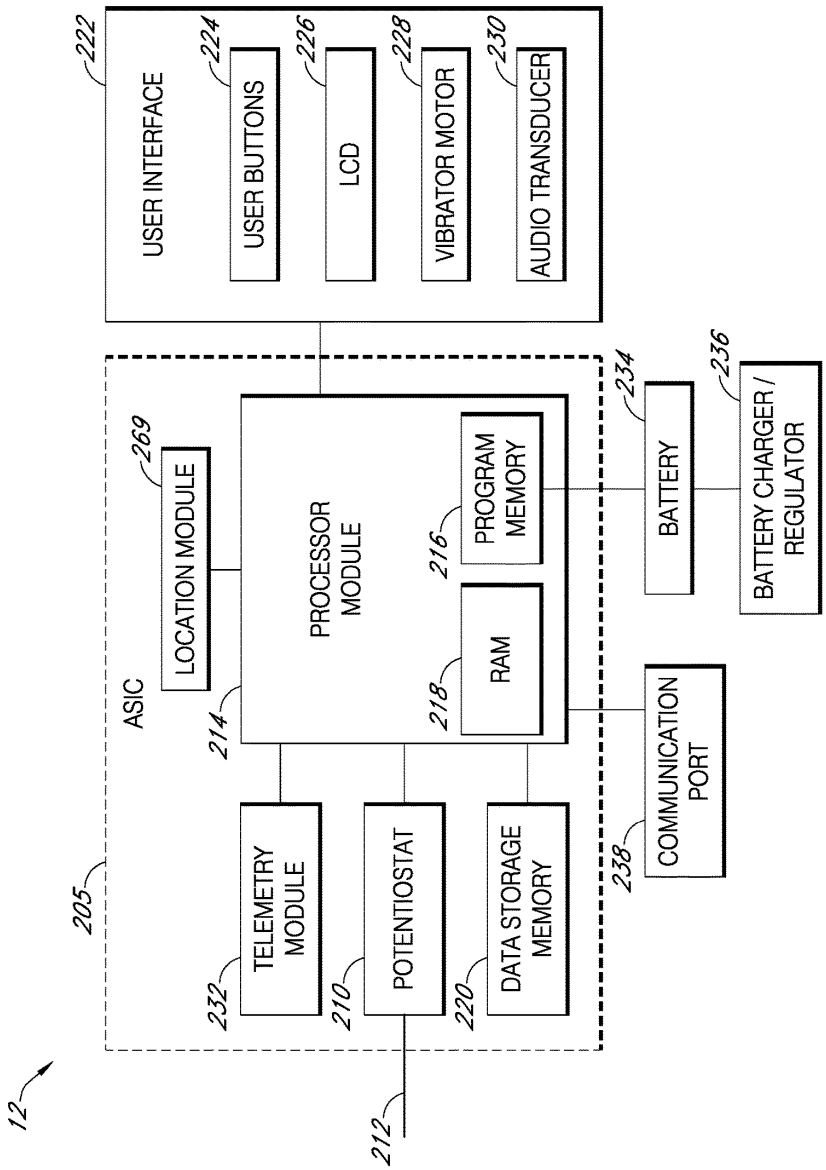
12
205
ASIC
269
LOCATION MODULE
214
PROCESSOR MODULE
216
PROGRAM MEMORY
218
RAM
222
USER INTERFACE
224
USER BUTTONS
226
LCD
228
VIBRATOR MOTOR
230
AUDIO TRANSDUCER
232
TELEMETRY MODULE
210
POTENTIOSTAT
220
DATA STORAGE MEMORY
212
234
BATTERY
236
BATTERY CHARGER / REGULATOR
238
COMMUNICATION PORT

FIG. 5

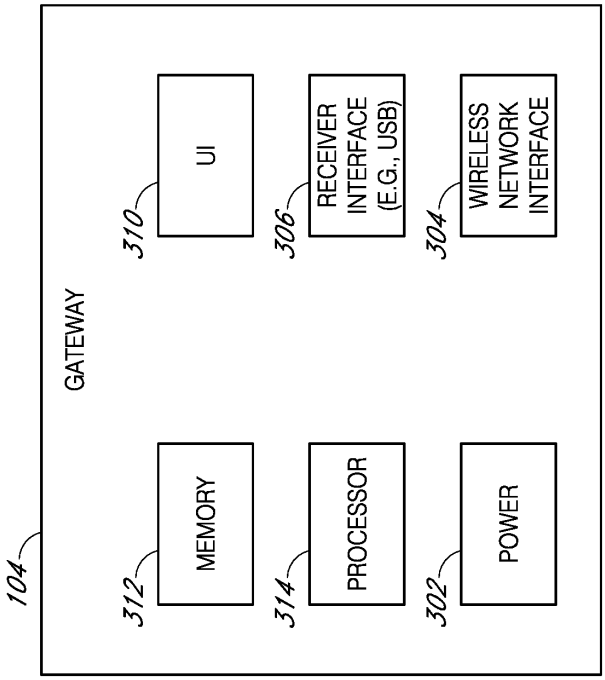
104
GATEWAY
312
MEMORY
314
PROCESSOR
302
POWER
310
UI
306
RECEIVER INTERFACE (E.G., USB)
304
WIRELESS NETWORK INTERFACE

FIG. 6

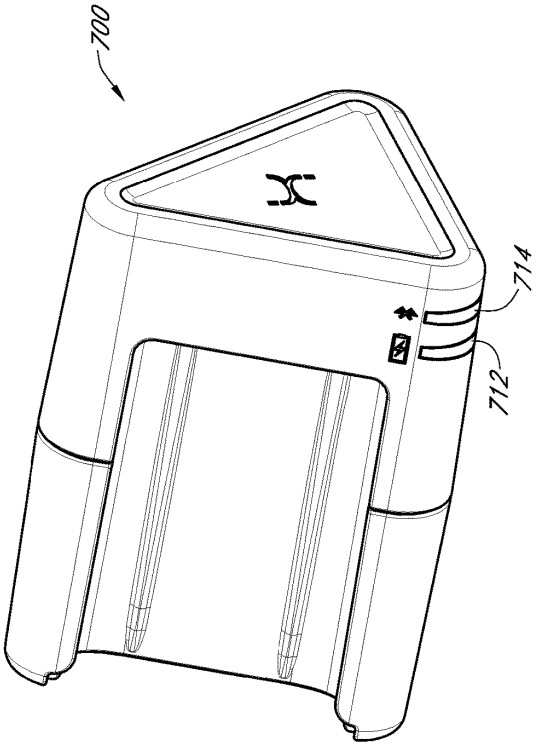

FIG. 7A

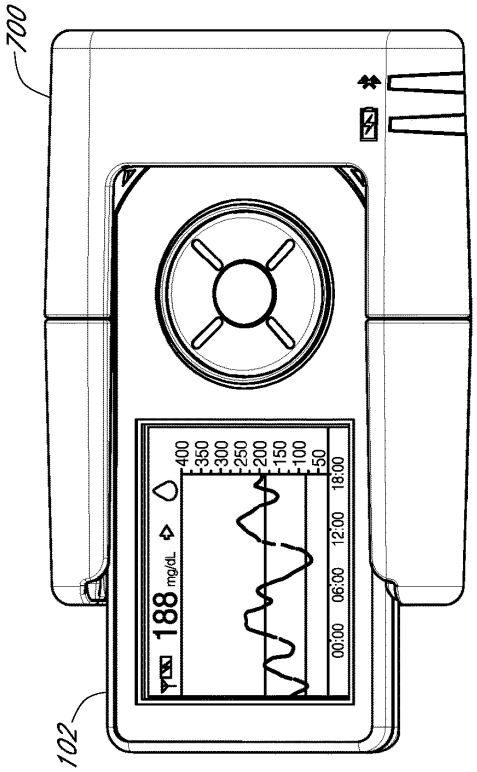
700
102
188 mg/dL
400
350
300
250
200
150
100
50
00:00
06:00
12:00
18:00

FIG. 7B

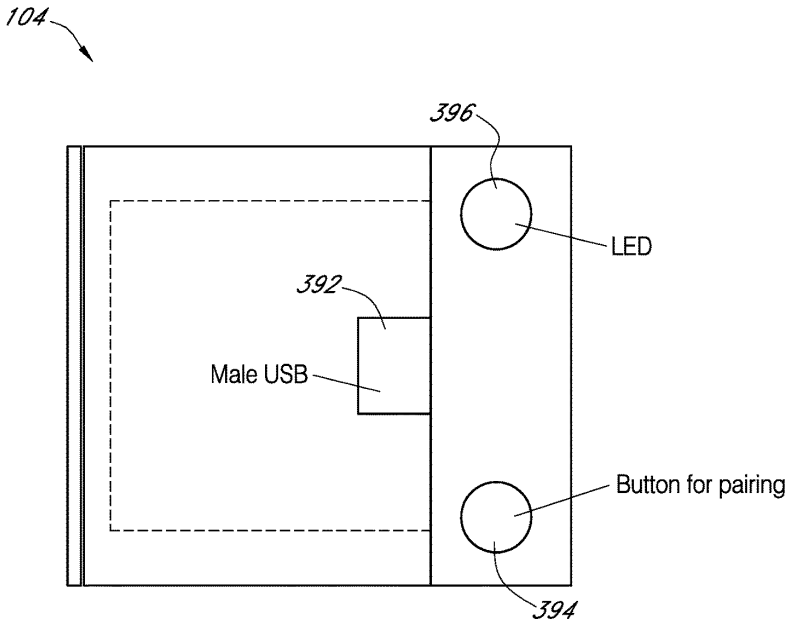

FIG. 8

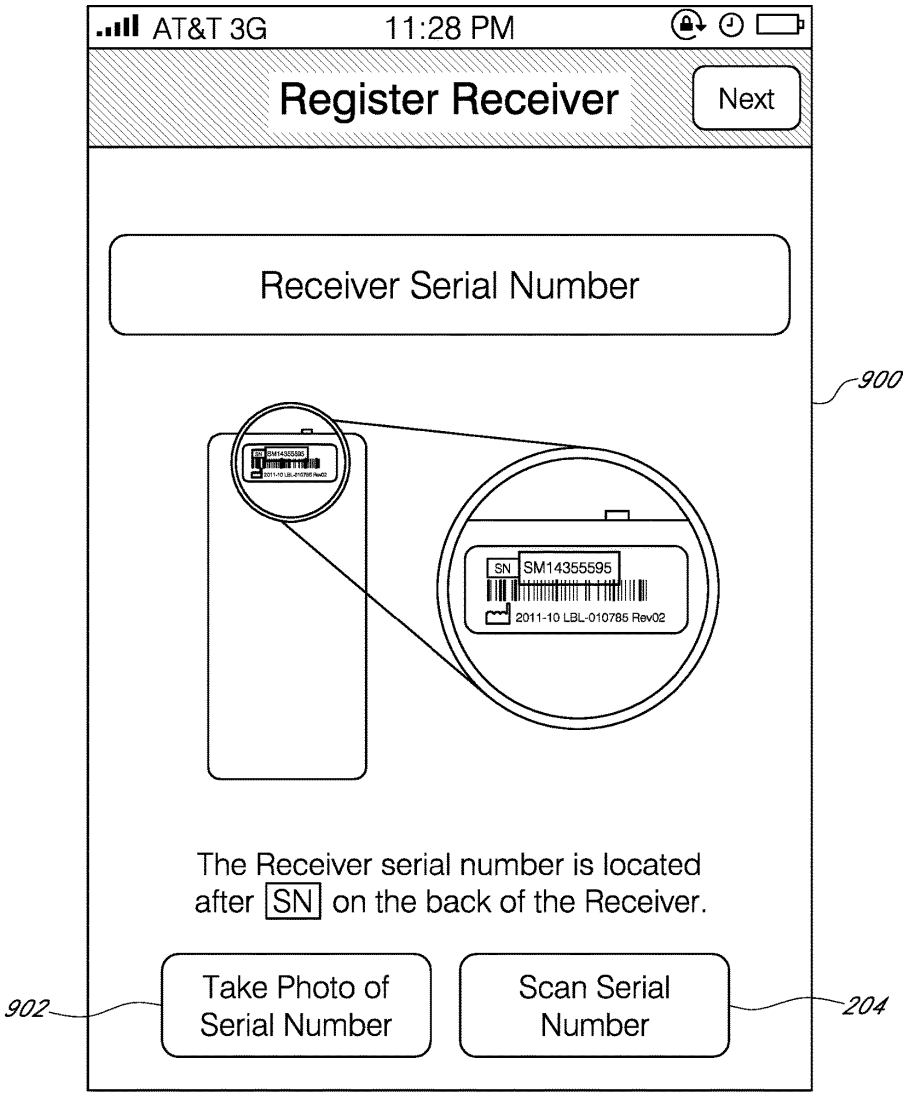
AT&T 3G
11:28 PM
Register Receiver
Next
Receiver Serial Number
900
SN
SM14355595
2011-10 LBL-010785 Rev02
The Receiver serial number is located after SN on the back of the Receiver.
902
Take Photo of Serial Number
Scan Serial Number
204

FIG. 9

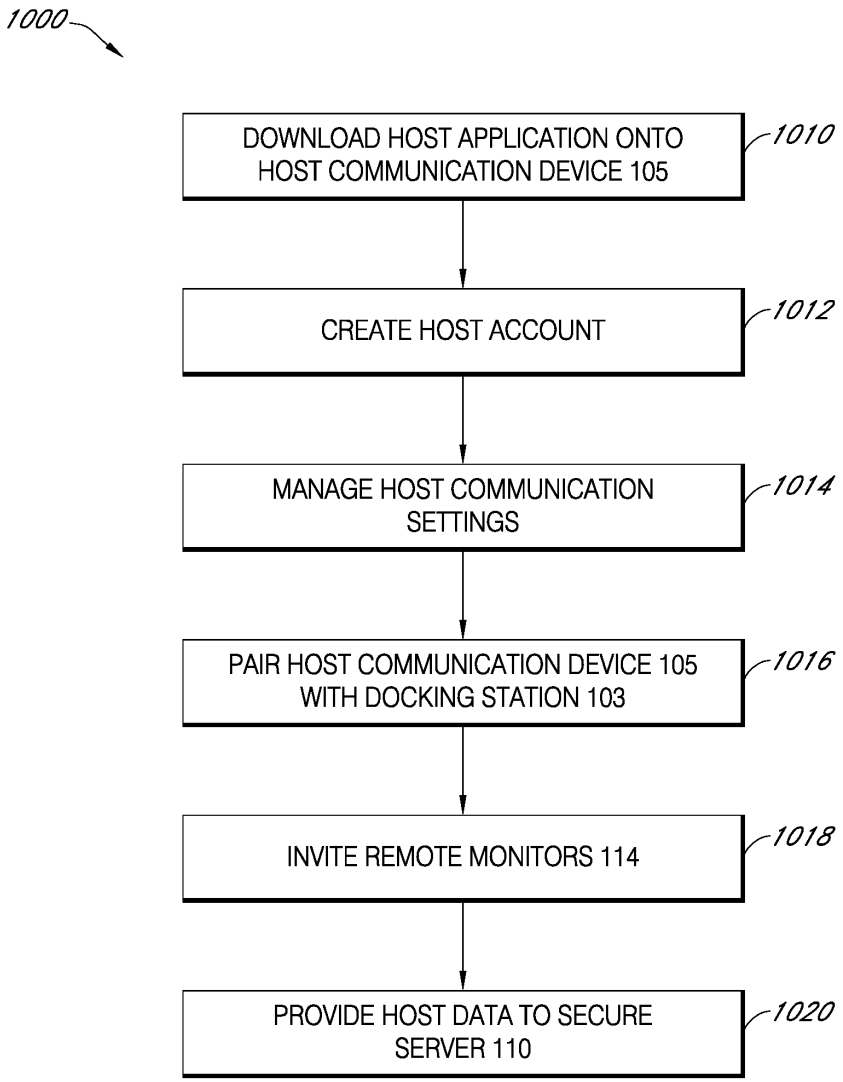
1000
DOWNLOAD HOST APPLICATION ONTO HOST COMMUNICATION DEVICE 105
1010
CREATE HOST ACCOUNT
1012
MANAGE HOST COMMUNICATION SETTINGS
1014
PAIR HOST COMMUNICATION DEVICE 105 WITH DOCKING STATION 103
1016
INVITE REMOTE MONITORS 114
1018
PROVIDE HOST DATA TO SECURE SERVER 110
1020

FIG. 10

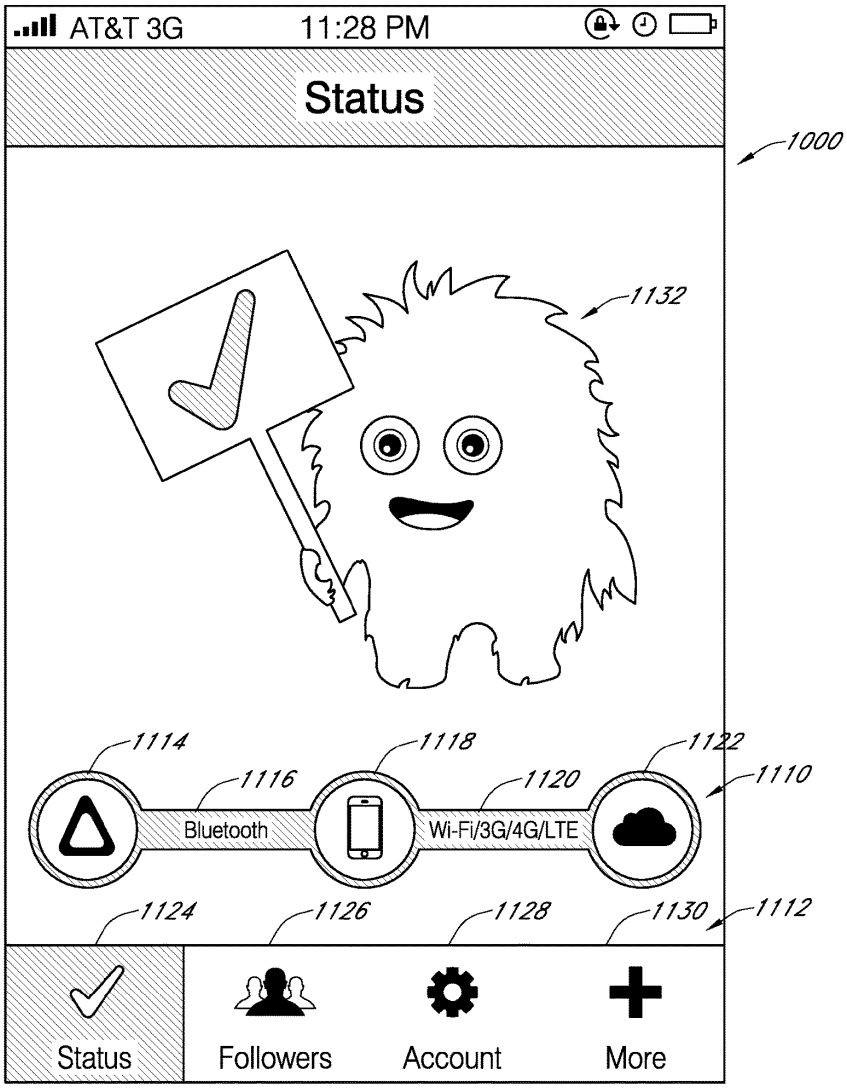
AT&T 3G
11:28 PM
Status
1000
1132
1114
1116
1118
1120
1122
1110
Bluetooth
Wi-Fi/3G/4G/LTE
1124
1126
1128
1130
1112
Status
Followers
Account
More

FIG. 11A

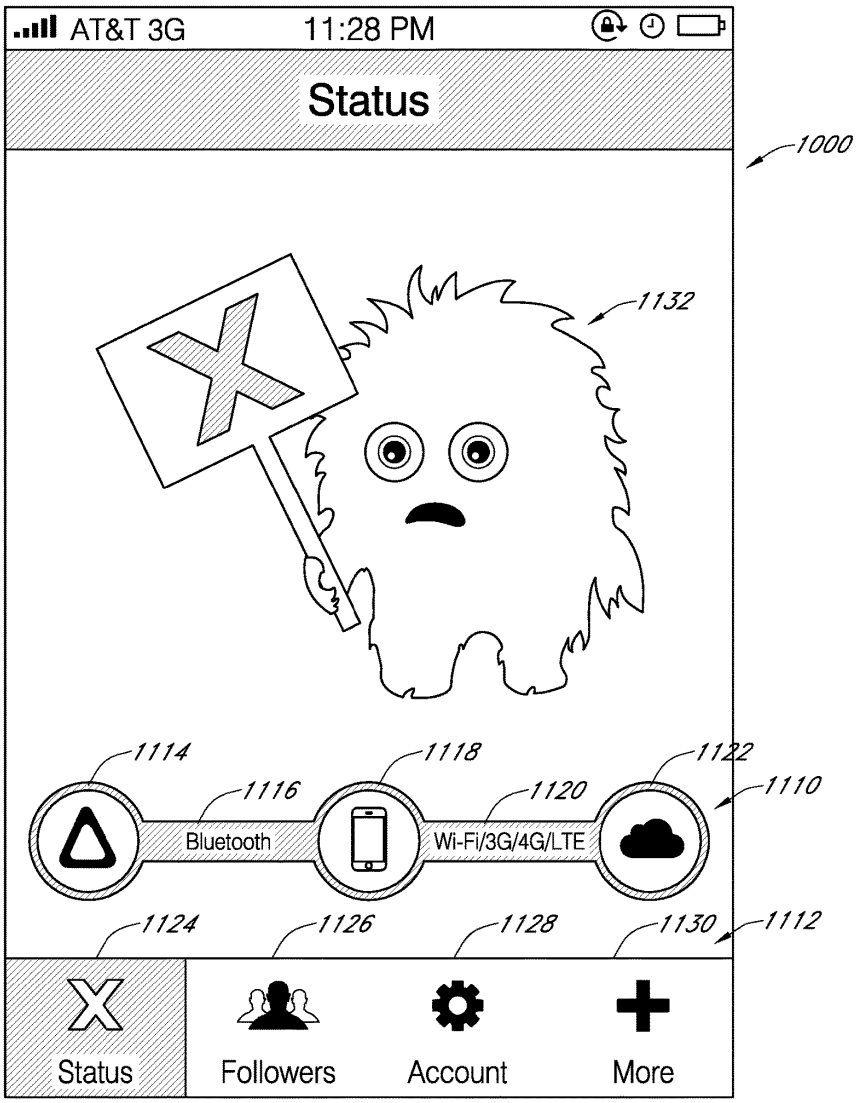
AT&T 3G
11:28 PM
Status
1000
1132
1114
1116
1118
1120
1122
1110
Bluetooth
Wi-Fi/3G/4G/LTE
1124
1126
1128
1130
1112
Status
Followers
Account
More

FIG. 11B

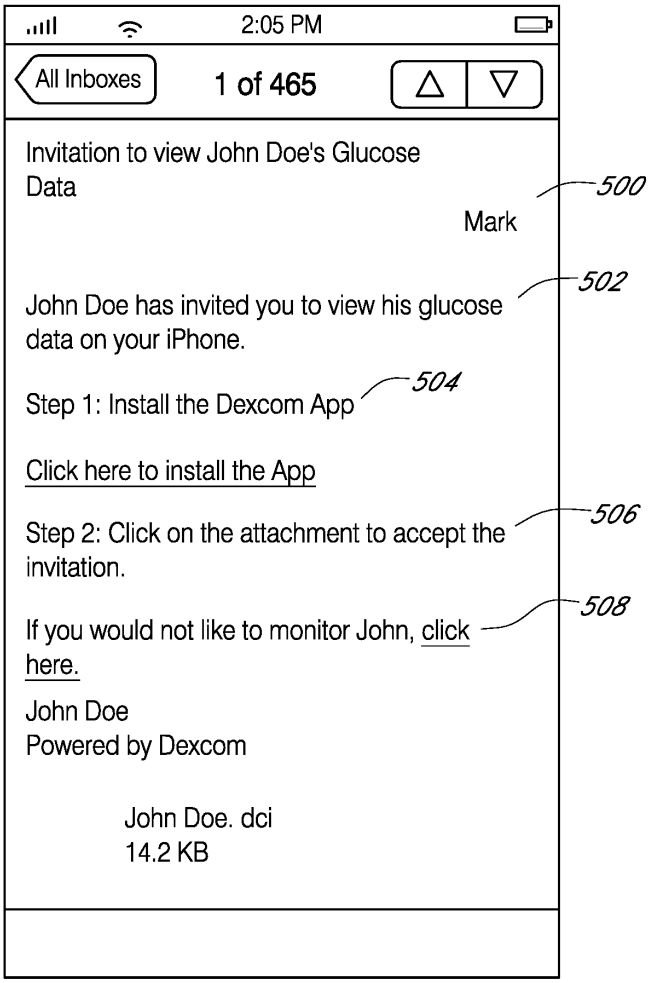
2:05 PM
All Inboxes
1 of 465
Invitation to view John Doe's Glucose Data
500
Mark
502
John Doe has invited you to view his glucose data on your iPhone.
504
Step 1: Install the Dexcom App
Click here to install the App
506
Step 2: Click on the attachment to accept the invitation.
508
If you would not like to monitor John, click here.
John Doe
Powered by Dexcom
John Doe. dci
14.2 KB

FIG. 12

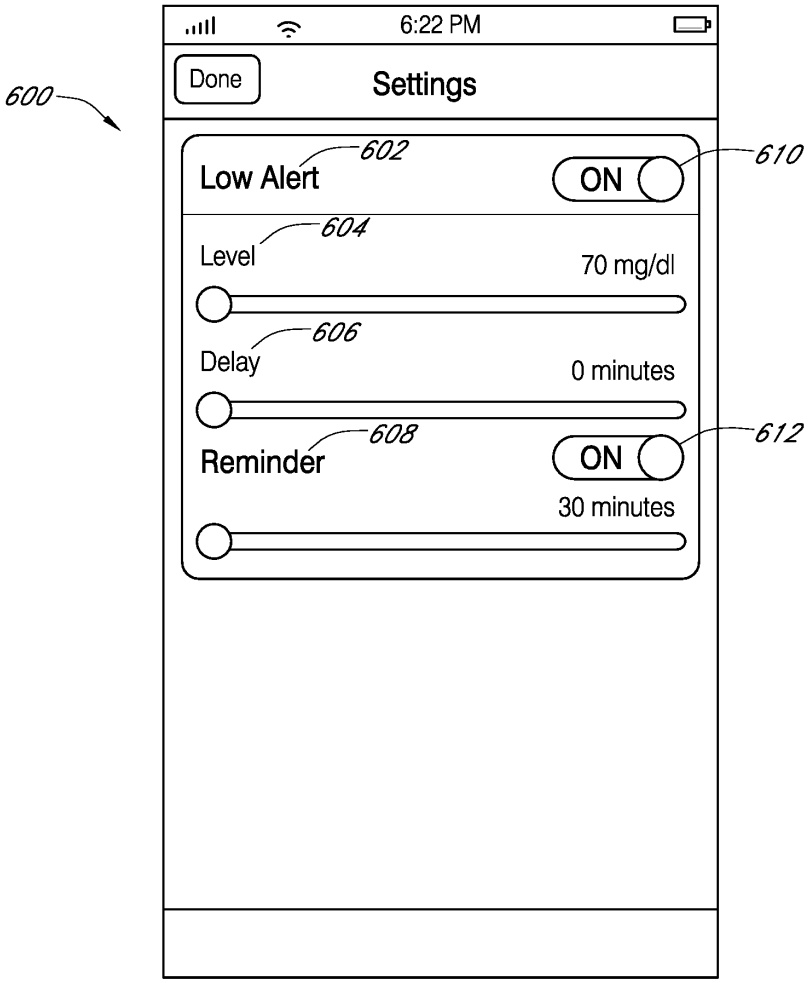
600
6:22 PM
Done
Settings
Low Alert
602
ON
610
Level
604
70 mg/dl
Delay
606
0 minutes
Reminder
608
ON
612
30 minutes

FIG. 13

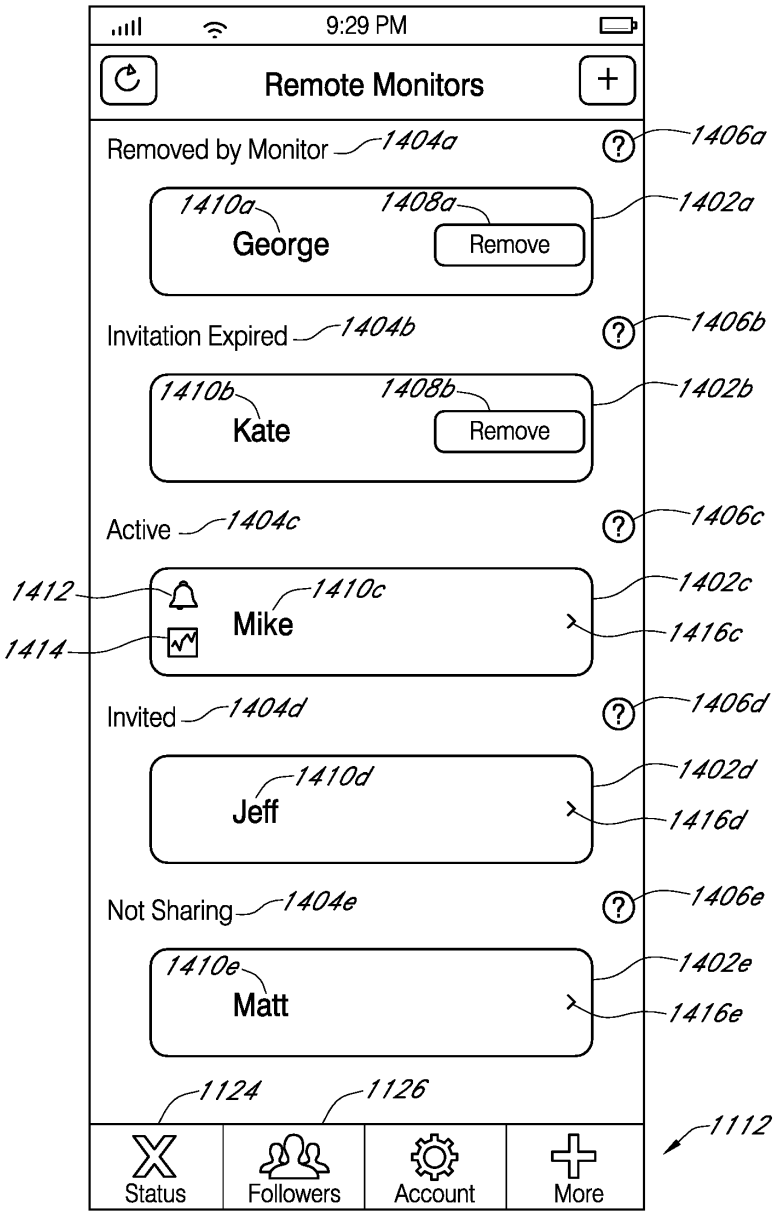
9:29 PM
Remote Monitors
Removed by Monitor
1404a
1406a
1410a
1408a
George
Remove
1402a
Invitation Expired
1404b
1406b
1410b
1408b
Kate
Remove
1402b
Active
1404c
1406c
1412
1410c
Mike
1402c
1414
1416c
Invited
1404d
1406d
1410d
Jeff
1402d
1416d
Not Sharing
1404e
1406e
1410e
Matt
1402e
1416e
1124
1126
1112
Status
Followers
Account
More

FIG. 14

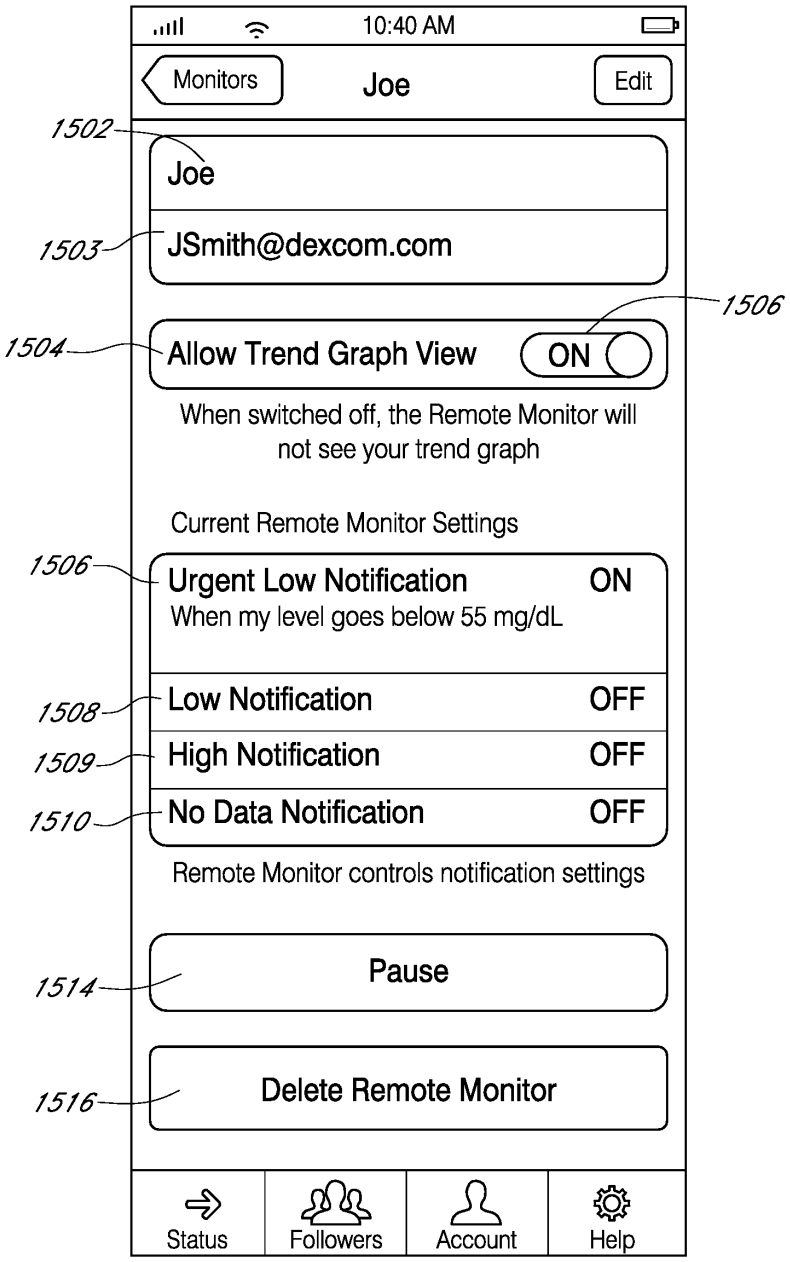
10:40 AM
Monitors
Joe
Edit
1502
Joe
1503
JSmith@dexcom.com
1506
1504
Allow Trend Graph View
ON
When switched off, the Remote Monitor will not see your trend graph
Current Remote Monitor Settings
1506
Urgent Low Notification
ON
When my level goes below 55 mg/dL
1508
Low Notification
OFF
1509
High Notification
OFF
1510
No Data Notification
OFF
Remote Monitor controls notification settings
1514
Pause
1516
Delete Remote Monitor
Status
Followers
Account
Help

FIG. 15

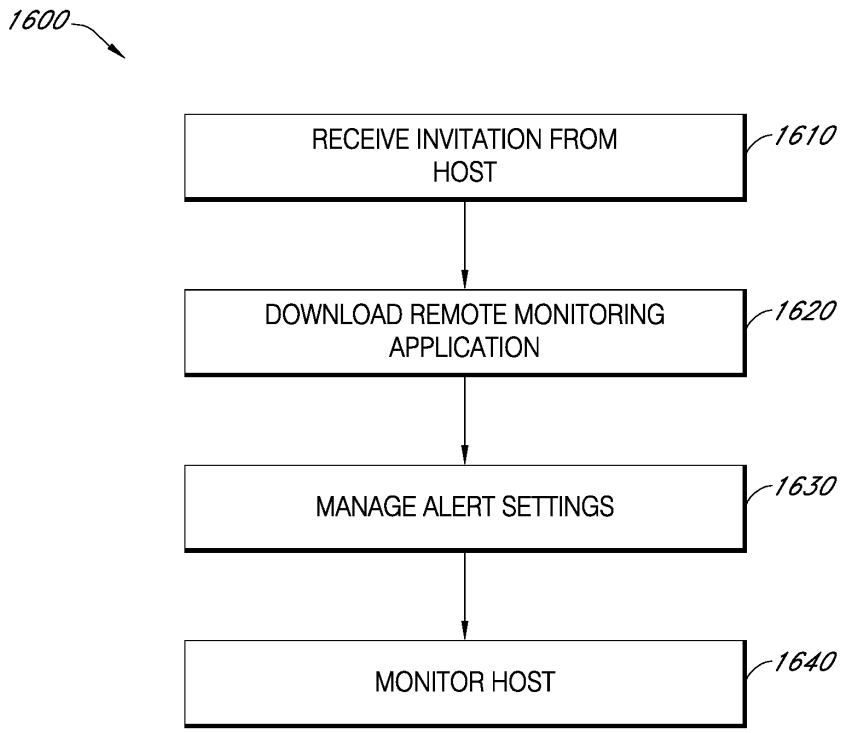
1600
RECEIVE INVITATION FROM HOST
1610
DOWNLOAD REMOTE MONITORING APPLICATION
1620
MANAGE ALERT SETTINGS
1630
MONITOR HOST
1640

FIG. 16

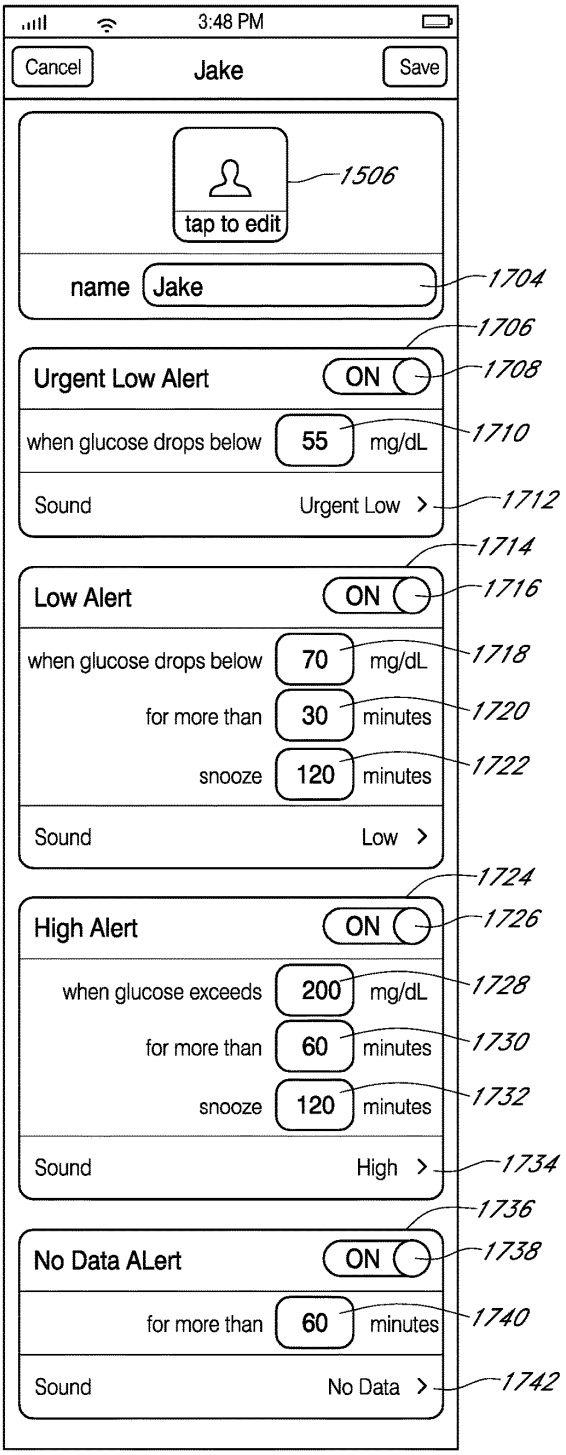
3:48 PM
Cancel
Jake
Save
tap to edit
1506
name
Jake
1704
1706
Urgent Low Alert
ON
1708
when glucose drops below
55
mg/dL
1710
Sound
Urgent Low
1712
1714
Low Alert
ON
1716
when glucose drops below
70
mg/dL
1718
for more than
30
minutes
1720
snooze
120
minutes
1722
Sound
Low
1724
High Alert
ON
1726
when glucose exceeds
200
mg/dL
1728
for more than
60
minutes
1730
snooze
120
minutes
1732
Sound
High
1734
1736
No Data ALert
ON
1738
for more than
60
minutes
1740
Sound
No Data
1742

FIG. 17

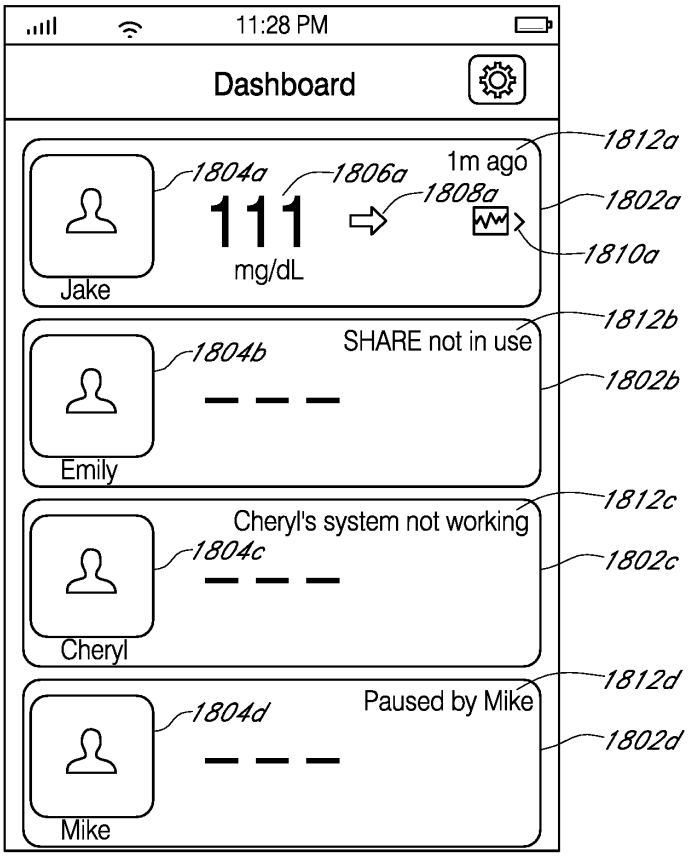
11:28 PM
Dashboard
1m ago
1804a
1806a
1808a
111
mg/dL
Jake
1812a
1802a
1810a
SHARE not in use
1804b
Emily
1812b
1802b
Cheryl's system not working
1804c
Cheryl
1812c
1802c
Paused by Mike
1804d
Mike
1812d
1802d

FIG. 18A

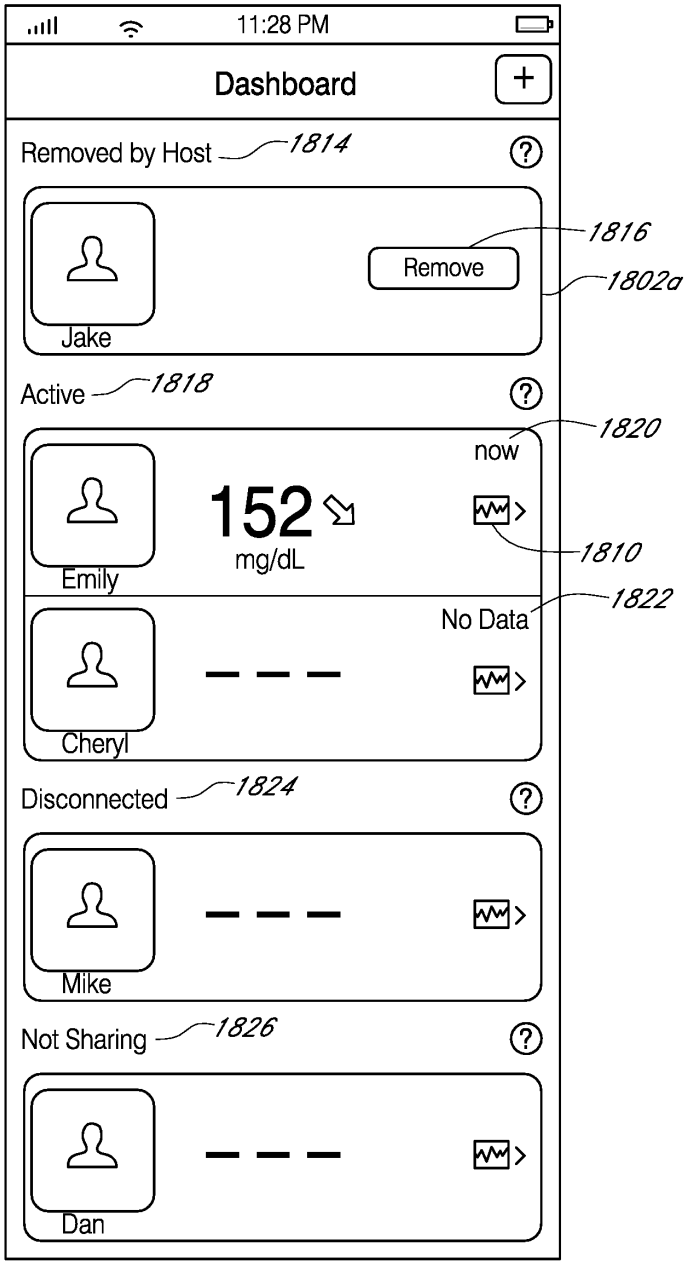
11:28 PM
Dashboard
+
Removed by Host
1814
Remove
1816
1802a
Jake
Active
1818
now
1820
152
mg/dL
1810
Emily
No Data
1822
Cheryl
Disconnected
1824
Mike
Not Sharing
1826
Dan

FIG. 18B

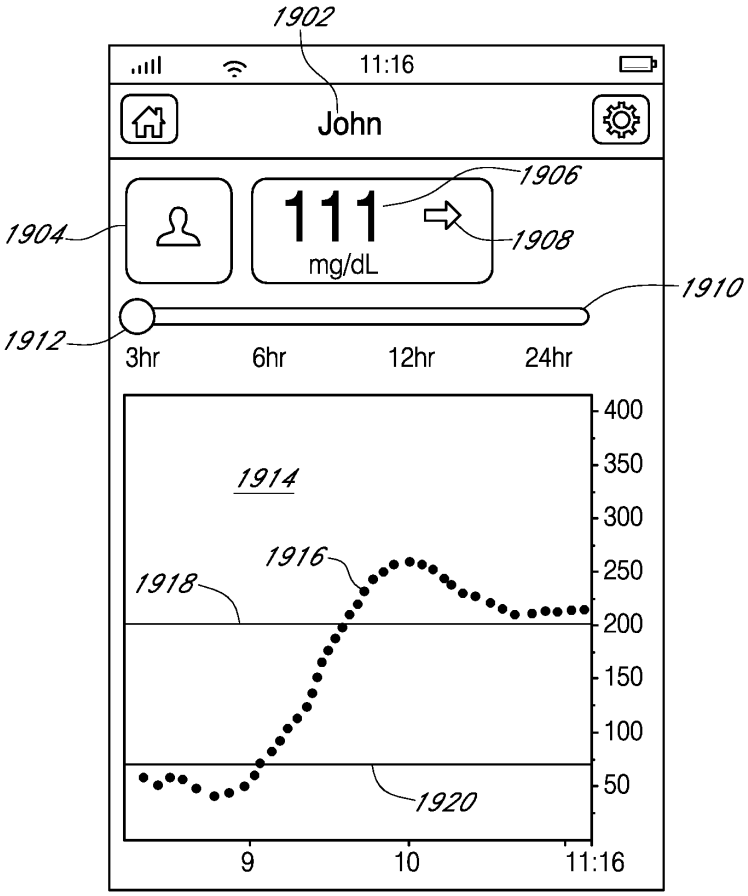
1902
11:16
John
1906
111
mg/dL
1904
1908
1910
1912
3hr
6hr
12hr
24hr
400
350
300
250
200
150
100
50
1914
1916
1918
1920
9
10
11:16

FIG. 19

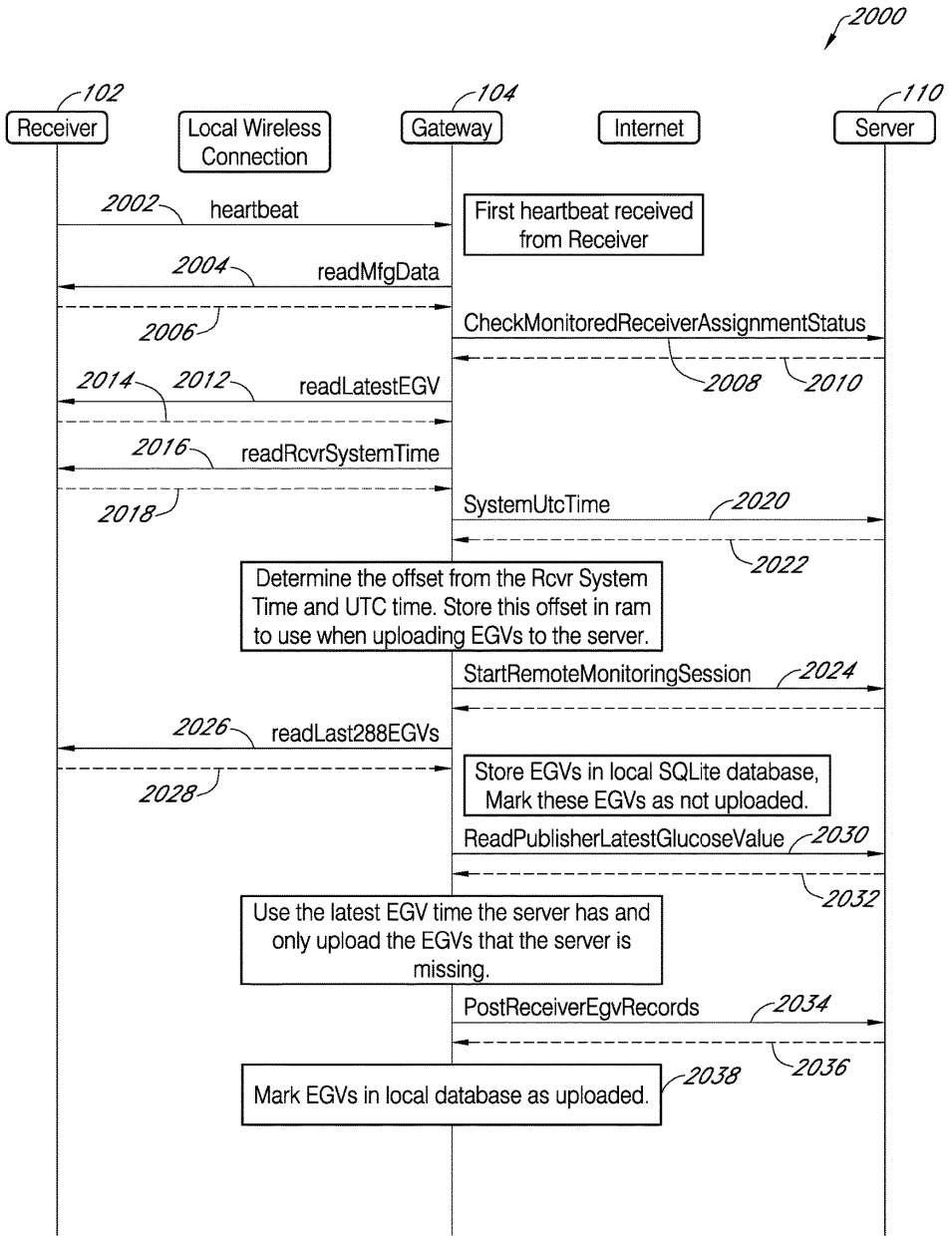
2000
102
Receiver
Local Wireless Connection
104
Gateway
Internet
110
Server
2002
heartbeat
First heartbeat received from Receiver
2004
readMfgData
2006
CheckMonitoredReceiverAssignmentStatus
2008
2010
2014
2012
readLatestEGV
2016
readRcvrSystemTime
2018
SystemUtcTime
2020
2022
Determine the offset from the Rcvr System Time and UTC time. Store this offset in ram to use when uploading EGVs to the server.
StartRemoteMonitoringSession
2024
2026
readLast288EGVs
2028
Store EGVs in local SQLite database, Mark these EGVs as not uploaded.
ReadPublisherLatestGlucoseValue
2030
2032
Use the latest EGV time the server has and only upload the EGVs that the server is missing.
PostReceiverEgvRecords
2034
2036
Mark EGVs in local database as uploaded.
2038

FIG. 20

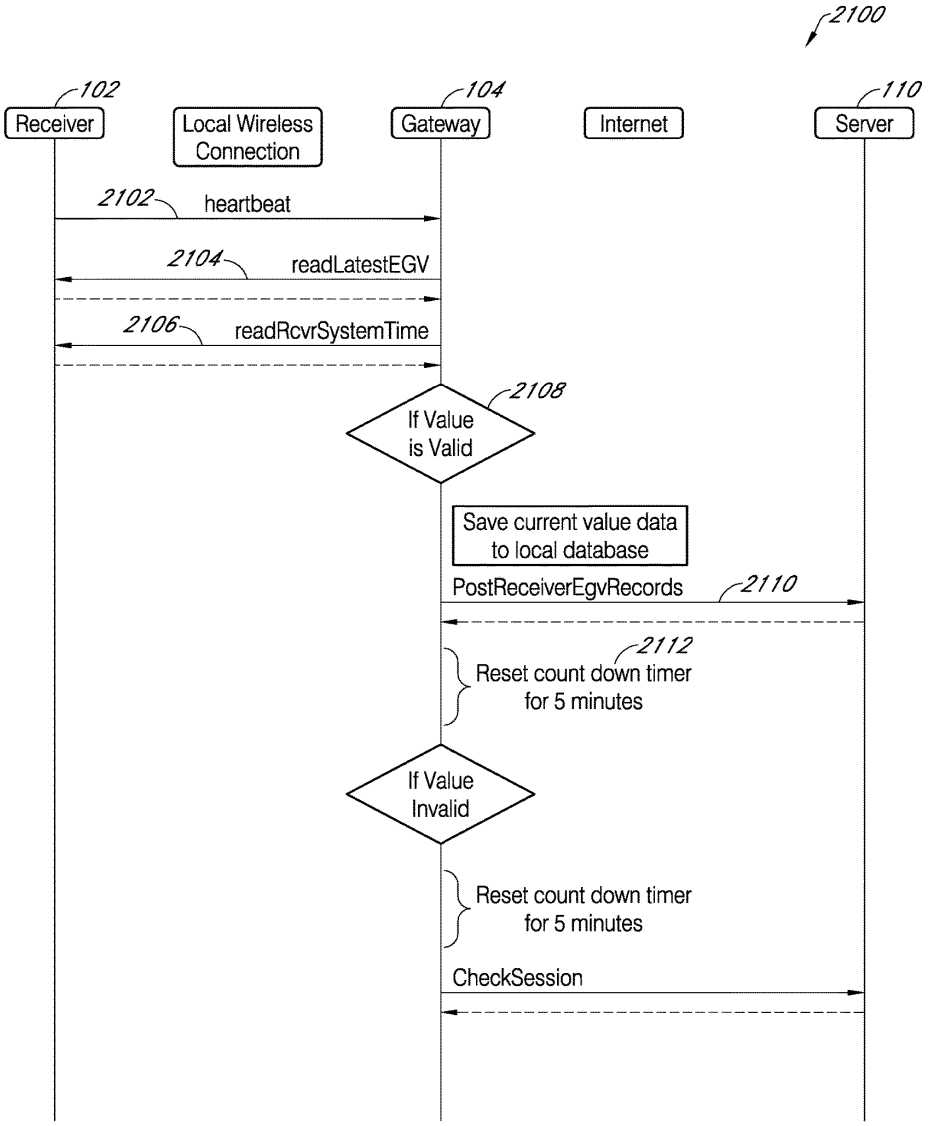
2100
102
Receiver
Local Wireless Connection
104
Gateway
Internet
110
Server
2102
heartbeat
2104
readLatestEGV
2106
readRcvrSystemTime
2108
If Value is Valid
Save current value data to local database
PostReceiverEgvRecords
2110
2112
Reset count down timer for 5 minutes
If Value Invalid
Reset count down timer for 5 minutes
CheckSession

FIG. 21

REMOTE MONITORING OF ANALYTE MEASUREMENTS

INCORPORATION BY REFERENCE TO RELATED APPLICATIONS

Any and all priority claims identified in the Application Data Sheet, or any correction thereto, are hereby incorporated by reference under 37 CFR 1.57. This application is a continuation of U.S. application Ser. No. 14/142,365 filed Dec. 27, 2013, which is a continuation-in-part of U.S. application Ser. No. 13/843,382 filed Mar. 15, 2013, which is a continuation of U.S. application Ser. No. 13/842,679 filed Mar. 15, 2013, which claims the benefit of U.S. Provisional Application No. 61/747,717 filed Dec. 31, 2012, the disclosures of which are hereby expressly incorporated by reference in their entirety and are hereby expressly made a portion of this application.

FIELD

The present disclosure generally relates to remote monitoring.

BACKGROUND

Diabetes mellitus is a disorder in which the pancreas cannot create sufficient insulin, such as in the case of Type I diabetes and/or in which insulin is not effective, such as Type 2 diabetes. In a diabetic state, a victim suffers from high blood sugar, which causes an array of physiological derangements, such as kidney failure, skin ulcers, or bleeding into the vitreous of the eye, associated with the deterioration of small blood vessels. A hypoglycemic reaction, such as low blood sugar, may be induced by an inadvertent overdose of insulin, or after a normal dose of insulin or glucose-lowering agent accompanied by extraordinary exercise or insufficient food intake.

A diabetic person may carry a self-monitoring blood glucose (SMBG) monitor, which typically requires uncomfortable finger pricking methods. Due to the lack of comfort and convenience, a diabetic typically measures his or her glucose level only two to four times per day. Unfortunately, these time intervals are spread so far apart that the diabetic will likely find out too late, sometimes incurring dangerous side effects, of a hyperglycemic or hypoglycemic condition. In fact, it is not only unlikely that a diabetic will take a timely SMBG value, but additionally the diabetic will not know if his blood glucose value is higher or lower based on conventional methods.

Consequently, a variety of non-invasive, transdermal (e.g., transcutaneous) and/or implantable electrochemical sensors are being developed for continuously detecting and/or quantifying blood glucose values. These as well as other types of devices generally transmit raw or minimally processed data for subsequent analysis at a remote device, which can include a display, to allow presentation of information to a user hosting the sensor.

SUMMARY

Methods, systems and apparatus, including computer program products, are provided for remote monitoring of analyte data. In some example implementations, there is provided a method. The method may include receiving, at a remote monitor, a notification message representative of an event detected, by a server, from analyte sensor data obtained from a receiver monitoring an analyte state of a host; presenting, at the remote monitor, the notification message to activate the remote monitor, wherein the remote monitor is configured by the server to receive the notification message to augment the receiver monitoring of the analyte state of the host; accessing, by the remote monitor, the server, in response to the presenting of the notification message; and receiving, in response to the accessing, information including at least the analyte sensor data.

In some example implementations, the above-noted aspects may further include additional features described herein including one or more of the following. The notification message may be received from at least a first wireless connection between the remote monitor and a notification service coupled to the server, wherein the additional information may be received from at least a second wireless connection between the remote monitor and the server. The first wireless connection may comprise a persistent, encrypted connection configured to carry a short message pushed by the notification service to a notification message center at the remote monitor, and wherein the second wireless connection may comprise a momentary, encrypted connection established, in response the accessing, to provide the additional information comprising at least additional analyte sensor data. The presenting may further comprise inhibiting access to one or more applications at the remote monitor until an action at the remote monitor is detected to indicate receipt of the notification message, wherein the remote monitor further may comprise a monitoring application. The notification message may be presented as a momentary message on a display at the remote monitor, without the inhibiting access. The at least one of the remote monitor and the receiver may comprise one or more of a mobile station, a wireless terminal, a tablet, a smart phone, a multi-mode wireless device, and a computer. The server may comprise at least one processor configured to receive analyte sensor data from the receiver, process the analyte sensor data to detect the event, and forward, when the event is detected, the notification message to the remote monitor based on one or more rules mapping the event to the remote monitor designated to receive the notification message for the detected event. The event may be detected based on a first set of rules at the server, wherein the first set of rules used to generate the notification message may be different from a second set of rules used to detect alerts sent to the receiver coupled to a sensor system at the host. The receiver may include, or couple to, a gateway interfacing a wireless connection to a public land mobile network and the server. A plurality of remote monitors may be configured, wherein at least one of the plurality of remote monitors may be designated as a primary monitor, and at least one of the plurality of remote monitors may be designated as a secondary monitor. The remote monitor may configure at least one rule representative of a trigger causing an alert to be sent by the server to the receiver. The remote monitor may configure one or more invitations sent to one or more devices to invite the one or more devices to monitor the receiver. The server may send a message acknowledging a receipt of the notification message. The notification message may include at least one of an indication of a need to calibrate a sensor and an acknowledgement message indicating at least one of an action or an acknowledgement sent by the receiver in response to an alarm sent to the receiver. The activation of the remote monitor may comprise opening the monitoring application. A connection may be established between the remote monitor and the server to enable the receiving of the information including the analyte sensor data. The server may register at

least one of the remote monitor, the receiver, an analyte sensor coupled to the receiver, and the registration may include a code provided by a health care provider. The method may be implemented on an apparatus comprising at least one processor and at least one memory including code, which when executed by the at least one processor causes the apparatus to provide the method. A computer-readable storage medium may include code which when executed by at least one processor causes the method.

In some exemplary implementations there is provided a method that includes receiving, at a remote monitor, an invitation to access a secure server and data associated with a receiver monitoring an analyte state of a host; and modifying, by the remote monitor, a rule defining an alert representative of an event associated with the analyte state of the host, wherein the alert, when triggered, causes a message to be sent to the remote monitor to notify the remote monitor of the event.

In some example implementations, the above-noted aspects may further include additional features described herein including one or more of the following. The modifying the rule may comprise varying a first threshold associated with a low level of glucose at the host, varying a second threshold associated with a high level of glucose at the host, varying a delay between when an associated alert is triggered by a receiver and a notification message is sent to the remote monitor, and/or varying a time value when a reminder notification is sent to the remote monitor. The method may be implemented on an apparatus comprising at least one processor and at least one memory including code, which when executed by the at least one processor causes the apparatus to provide the method. A computer-readable storage medium may include code which when executed by at least one processor causes the method. In some implementations, there is provided a method or system, including computer program products, for wireless communication between computing devices of a continuous glucose monitoring system. The method may comprise: receiving, using a gateway device, a heartbeat message from a receiver, the heartbeat message triggering connection logic; requesting a latest analyte concentration value and a receiver time from the receiver; identifying sensor data gaps of analyte concentration data stored at a remote server; requesting, using the gateway, one or more timeframes of sensor data from the receiver based on the identified data gaps; and providing the sensor data to the server.

The above-noted implementations may further comprise: requesting manufacturing data from the receiver, wherein the manufacturing data comprises a unique identifier associated with the receiver; and checking a status of the receiver based on the manufacturing data, the checking comprising sending a message to the remote server and subsequently receiving an indication of whether the status of the receiver is valid or invalid from the remote server, wherein the requesting of the latest analyte value only occurs if the status of the receiver is valid.

The above-noted implementations may further comprise: requesting a universal time from the server; and calculating a drift in time based on a difference between the receiver time and the universal time, wherein identifying the sensor data gaps is based on the drift in time. Further, the above-noted aspects may store the drift in memory of the gateway device.

In some implementations, there is provided a method or system, including computer program products, for wireless communication between computing devices of a continuous glucose monitoring system, comprising: iteratively receiving a heartbeat message transmitted by a receiver; determining if it is time to request data from the receiver responsive to each received heartbeat message based on whether more than a predetermined amount of time has elapsed based on a heartbeat counter; and obtaining glucose concentration data from the receiver if it is determined that it is time to request sensor data from the receiver.

In the above-noted implementations, the obtaining may further comprise requesting a latest glucose value data and a current system time from the receiver, and uploading the requested latest glucose value data to a remote server upon receipt of the requested latest glucose value data.

The above-noted implementations may further comprise determining if the latest glucose value data is valid; and if determined to be valid, storing the requested latest glucose value data locally and resetting the heartbeat counter.

The above-noted implementations may further comprise resetting the heartbeat counter without storing the latest glucose value locally if the data is determined not to be valid.

The above-noted implementations may further comprise transmitting a CheckSession call to the server to keep a current login session active.

In some implementations, there is provided a method or system, including computer program products, for monitoring a host's glucose levels measured using a continuous glucose monitoring system, comprising: receiving a voice input using a mobile computing device; processing the voice input to determine one or more commands; and implementing the one or more commands.

The above noted implementations may also include one or more of the following: wherein the one or more commands include outputting a particular glucose value; wherein the particular glucose value is the current glucose value; wherein the voice input comprises an indication of a past time frame and the particular glucose value is a glucose value corresponding to the past time frame; wherein the outputting comprises audibly providing the particular glucose value using the mobile computing device and displaying the current glucose value on a display of the mobile computing device; wherein outputting further comprises triggering display of a glucose trend graph of the host's measured glucose concentration over time; wherein the one or more commands is calibrating the glucose monitoring system using a calibration value indicated in the voice input confirming the calibration value based on a difference between the calibration value and a current glucose value associated with the host wherein the voice input comprises an instruction to modify alert settings of the continuous glucose monitoring system, and wherein the one or more commands comprise modifying one or more alert settings in accordance with the instructions; wherein modifying the alert settings comprises one or more of modifying and alarm profile, changing an alarm threshold, and turning off or on a particular alarm; wherein the voice input comprises an acknowledgement of an alert previously triggered by the remote monitoring system, and wherein the one or more commands comprise turning off the triggered alert; wherein the voice input comprises an indication of one of a plurality of host's a user is remotely monitoring using the glucose monitoring system; wherein the one or more commands includes selecting the host and wherein the outputting comprises audibly providing and/or displaying a state of the host; and wherein the state of the host comprises one or more of a current glucose value of the host, a rate of change of glucose concentration of the host, and a location of the host.

In some implementations, there is provided a method or system, including computer program products, for monitoring a host's glucose levels measured using a continuous glucose monitoring system, comprising: enabling a voice feedback setting of the continuous glucose monitoring system using a mobile computing device; receiving continuous glucose sensor data measured by the continuous glucose monitoring system; processing the continuous glucose sensor data; and outputting voice feedback using the mobile computing device in accordance with the voice feedback setting and the processed continuous glucose sensor data.

The above noted implementations may also include one or more of the following: wherein enabling the voice feedback setting includes selecting at least one of a plurality of alert parameters; and wherein the plurality of alert parameters comprises a time interval for automatically providing voice feedback, a glucose threshold and a rate of change threshold.

It is to be understood that both the foregoing general description and the following detailed description are example and explanatory only and are not restrictive. Further features and/or variations may be provided in addition to those set forth herein. For example, the implementations described herein may be directed to various combinations and subcombinations of the disclosed features and/or combinations and subcombinations of several further features disclosed below in the detailed description.

DESCRIPTION OF THE DRAWINGS

In the drawings,

FIG. **1** depicts a high-level system architecture of a remote monitoring system in accordance with some exemplary implementations;

FIGS. **2**A-**2**C illustrate different system architectures of the remote monitoring system of FIG. **1** in accordance with some exemplary implementations;

FIG. **3** depicts an example process for notifying a remote monitor of an event in accordance with some example implementations;

FIGS. **4**A and **4**B depict examples of notification messages **170** and **172**, respectively, in accordance with some implementations;

FIG. **5** depicts an example of a sensor electronics module in accordance with some example implementations;

FIG. **6** is a block diagram of an implementation of a gateway in accordance with some implementations;

FIGS. **7**A and **7**B depict an example of a docking station in accordance with some implementations;

FIG. **8** depicts an implementation of a gateway or docking station in accordance with some implementations;

FIG. **9** illustrates an exemplary display page to facilitate entry of the serial number of a receiver or other unique identifier in accordance with some implementations;

FIG. **10** is a flow chart depicting a process for setting up host monitoring system in accordance with some implementations;

FIGS. **11**A and **11**B are exemplary views of a status page in accordance with some implementations;

FIG. **12** depicts an example invitation page presented at a remote monitor in the form of an email message in accordance with some implementations;

FIG. **13** depicts an example alert setting page that may be presented on a display of the host computing device;

FIG. **14** illustrates an overview page of remote monitors displayed by a host monitoring device in accordance with some implementations;

FIG. **15** is an exemplary remote monitor settings display page displayed by a host monitoring device in accordance with some implementations;

FIG. **16** is a flowchart of an exemplary remote monitor set up process in accordance with some implementations;

FIG. **17** is an implantation of a settings page that can allow the remote monitor to configure remote monitoring settings of a host in some implementations;

FIGS. **18**A and **18**B are two different implementations of a dashboard page displayed by a remote monitor in accordance with some implementations; and

FIG. **19** is an exemplary page that provides a trend graph of a host's monitored analyte concentration in accordance with some implementations;

FIG. **20** is a diagram of wireless connection processing in accordance with some implementations; and

FIG. **21** is a diagram of steady state wireless connection processing in accordance with some implementations.

DETAILED DESCRIPTION

Implementations described herein can include a system for one or more caretakers (e.g., a parent, spouse or healthcare practitioner) to remotely monitor health characteristics of one or more hosts. The health characteristics can include an analyte concentration of a host, such as glucose, or a bodily function, such as heart rate, blood pressure, or temperature, and the like. In addition, other characteristics of a host can be monitored to facilitate care of a host, such as a geographic location of the host, state of a host (e.g., exercising, sleeping, or working) and the like. The health characteristics and other characteristics can be gathered using a host monitoring system that incorporates a computing device, such as a smart phone, and one or more sensors, such a continuous glucose sensor, heart-rate monitor, GPS device, etc. Additionally, a host can manually input information into the computing device, such as meal information, medication administration times and amounts, and the like. The information gathered by the host monitoring system can then be transmitted to one or more remote monitors used by caretakers. The caretaker(s) can then receive information about the host's health condition using a remote monitoring system. In some implementations, a host monitoring system can transmit information directly to the one or more remote monitors and/or the host monitoring system transmits information first to a remote server, which then transmits information to the host monitor.

For purposes of illustration only, the following example is a non-limiting exemplary environment in which implementations of remote monitoring systems described herein can be used.

In this exemplary environment, a host having diabetes is monitored by several different caretakers. The host has a continuous glucose monitoring system, such as the DexCom G4® Platinum continuous glucose monitoring system, commercially available from DexCom, Inc., which provides measurements of the host's glucose levels on a display device, such as the DexCom G4® Platinum Receiver, also commercially available from DexCom, Inc.

Further, in this exemplary environment, the display device can be in communication with a gateway device, such as via wired communication or wireless communication. The gateway device gathers information, including real-time or near-real-time glucose concentration values, from the display device and transmits the information to a secure server. The gateway device can include a smartphone, such as an iPhone® 4S or iPhone 5, each commercially available

from Apple, Inc., and a host monitoring software application that comprises instructions configured to cause the smartphone to function as the gateway. The host monitoring software application can be in the form of a so-called "App" downloaded from the Apple App Store^{SM} operated by Apple, Inc. The gateway can transmit information gathered from the continuous glucose monitoring system wirelessly to the secure server over a cellular network, Wi-Fi network, and the like.

The remote server can store and monitor the information received from the remote monitoring system. The monitoring can include comparing glucose values of the host (generated by the continuous glucose monitoring system and transmitted to the server via the gateway) to predetermined thresholds and initiating an action if a threshold is exceeded. For example, the server can compare a current glucose value (e.g., the most recently viewed glucose value) with a predetermined glucose threshold and initiate a notification, such as a text message over a cellular network, to a remote monitoring system if the glucose value exceeds the threshold. The server can also provide historical and current glucose values to the remote monitoring system on demand.

As discussed above, the remote monitor can be used by a caretaker to monitor health characteristics of a host, which in this exemplary environment is a glucose concentration level of the host. Similar to the host monitoring system, the remote monitoring system can be a smartphone, such as an iPhone 4S or iPhone 5, and a remote monitoring software application that comprises instructions configured to cause the smartphone to function as the remote monitoring system. The remote monitoring software application can be in the form of a so-called "App" downloaded from the Apple App Store operated by Apple, Inc. The remote monitoring system can receive notifications from the server when a threshold is exceeded, notifying the caretaker using the remote monitoring system of the condition of the host. The remote monitoring system can also be used to view historical information about the monitored glucose levels of the host and modify notification rules, such as the threshold levels that trigger notifications.

The following provides more detail of specific implementations, which may or may not include features noted in the above-discussed exemplary environment.

FIG. **1** depicts a high-level system architecture of an implementation of remote monitoring system **100**. Here, remote monitoring system **100** includes a plurality of host monitoring systems **198**A-**198**N connected to a plurality of remote monitors **114**A-**114**M via network **118**. Each host monitoring system **198** may be one or more health monitoring devices that gather health-related data associated with a host and transmit the health-related data via network **108**. Exemplary implementations of health monitoring systems **198**A-**198**N are described in more detail elsewhere in this disclosure, but in some implementations can include one or more sensors and computing devices operably coupled to the sensors to gather, process and transmit the health-related data. Network **108** can include any communication medium, such as wired and wireless networks including cellular networks, local area networks, wide area networks, Wi-Fi networks, the internet, and the like. Network **108** can also include one or more servers **110** to process the health-related data received from and transmit notifications and data to one or more remote monitors **114**A-**114**M either automatically or in response to a request from the remote monitors.

Each remote monitor **114**A-**114**M can be associated with an individual or entity that is monitoring the health of one or more of hosts using host monitoring systems **198**A-**198**N. Each remote monitor **114** can be associated with a caretaker, such as parent, spouse, doctor, nurse, hospital and the like. The remote monitor **114** can include a computing device that receives notifications from network **108** and requests additional information, such as historical health-related data generated by one or more host monitoring systems **198**A-**198**N.

Remote monitoring system **100** of FIG. **1** can also include workstation **22**. Workstation **22** may be a computing device, such as a personal computer, that has access to remote monitoring system **100** for configuring settings of system **100** and/or viewing information associated with one or more host monitoring systems **198**, such as reports generated by remote monitoring system based on a host's health-related data.

Using remote monitoring system **100** of FIG. **1**, one or more remote monitors **114**A-**11**M can monitor one or more host monitoring systems **198**A-**198**N. As an example, host monitoring system **198**A can be monitored by remote monitors **114**A and **114**B, and at the same time, remote monitor **114**A can monitor host monitoring system **198**B as well. Various permissions and invitations can be used to limit which remote monitors **114**A-**114**M can monitor host monitoring systems **198**A-**118**N, as described in more detail later in this disclosure.

In one non-limiting example of remote monitoring system **100**, each host monitoring system **198**A-**198**N comprises a smart device, such as an iPhone mobile phone or iPod Touch® mobile device from Apple, Inc., and, likewise, each remote monitor **114**A-**114**M has a smart device, such as an iPhone or iPod touch. Each host smart device has a host software application downloaded from a server of network **108**, the application configuring the smart device to perform any of the functions by host monitoring system **198** described herein, including gathering and transmitting health-related data used in remote monitoring system **100**. The host software application can be an application downloaded using the App Store service hosted by Apple, Inc. Similarly, each remote monitor **114**A-**114**M has a remote monitoring application downloaded from a server of network **108**, the remote monitoring application configuring to perform any of the remote monitoring functions described herein, including receiving notifications and requesting health-related data of a host. The remote monitoring application can also be a software application downloaded using the App Store service hosted by Apple, Inc.

FIG. **2**A depicts an example of system **100** for monitoring health-related information of host **199**, in accordance with some example implementations. Here, the remote system **100** includes a continuous analyte monitoring system **8** including a sensor electronics module **12** and a continuous analyte sensor **10**. The system **100** may also include other devices and/or sensors, such as medicament delivery pump **2** (e.g., an insulin or glucagon pump), a glucose meter **4** (e.g., a blood finger stick meter), and any other device and/or sensor. The continuous analyte sensor **10** may be physically connected to sensor electronics module **12** and may be integral with (e.g., non-releasably attached to) or releasably attachable to the continuous analyte sensor **10**.

The sensor electronics module **12**, medicament delivery pump **2**, a glucose meter **4**, and/or other devices/sensors may couple via a wired or wireless links to one or more devices, such as a receiver **102**. The receiver **102** may include a display **122** to enable the host **199** to present information from and/or control continuous analyte sensor **10**, delivery pump **2**, glucose meter **4**, and/or other devices/sensors.

The implementation of system **100** illustrated in FIG. **2**A provides via a gateway **104**, networks **108**A-C, a secure server **110**, and a notification service **112**, notification messages to one or more remote monitors **114**A-**114**M, such as remote monitor **114**A. Each remote monitor **114** may be configured at system **100** to provide a separate mechanism for monitoring the activity associated with host **199** including receiver **102**, continuous analyte sensor **10**, delivery pump **2**, glucose meter **4**, and/or any other sensor associated with host **199**.

To illustrate by way of an example, host **199** may access receiver **102** to view data from, or control aspects of, continuous analyte sensor **10**, delivery pump **2**, and/or glucose meter **4**. However, another entity, such as a parent, a care giver, a health care professional, a school nurse, and the like, may have remote monitor **114** receive notification messages representative of certain events determined based on sensor data from receiver **102**, continuous analyte sensor **10**, delivery pump **2**, and/or glucose meter **4**, and view historical and substantially real-time sensor data. For example, an event may comprise one or more of the following: a measured analyte sensor value above or below a predetermined threshold, a rate of change or a level of glucose measurements above a predetermined threshold, a predicted glucose value approaching (or predicted to approach) a predetermined threshold, a host **199** not responding to a prompt, a message, or an alert displayed at receiver **102**, and/or any other event detected by secure server **110** and/or receiver **102**. In the example of FIG. **2**A, the remote monitor **114** depicts a notification message **132** indicating low glucose level of host **199**. As such, an entity having remote monitor **114** may assist host **199** by providing an additional layer of monitoring and oversight of host **199**, as well as receiver **102**, continuous analyte sensor **10**, delivery pump **2**, glucose meter **4**, and the like.

In some example implementations, the remote monitor **114** may include a processor, a non-transitory computer-readable storage medium (e.g., memory, storage, and the like), a radio access mechanism (e.g., a modem and the like), and/or a user interface. The computer readable medium may include code which when executed by a processor provides one or more applications, operating systems, and the like. For example, an application may be configured as a remote monitoring application configured to monitor and/or control one or more of the receivers **102**, the continuous analyte sensor **10**, the delivery pump **2**, the glucose meter **4**, and the like. In some implementations, the remote monitor **114** is an iPhone mobile phone from Apple, Inc. and the application is an application downloaded over the Internet using the App Store service operated by Apple, Inc.

In some example implementations, the remote monitor **114** may comprise one or more of the following: a mobile station, a wireless terminal, a tablet, a smart phone, or the like. For example, the remote monitor **114** may be implemented as a wireless handheld device, a wireless plug-in accessory, or the like. Moreover, the remote monitor **114** may be implemented as multi-mode device configured to operate using a plurality of radio access technologies, such as Long Term Evolution (LTE), wireless local area network (WLAN) technology, such as 802.11 Wi-Fi and the like, Bluetooth, Bluetooth low energy (BT-LE), near field communications (NFC), and any other radio access technologies. Moreover, the remote monitor **114** may be configured to establish connections to access points in network **108**A, such as cellular base stations, Wi-Fi access points, and the like, using at least one of the plurality of the radio access technologies. It is also understood that while some of the examples herein refer to the remote monitor **114** as a mobile, wireless computing device for purposes of explanation wherein, the remote monitor may be implemented as a stationary device, such as a personal computer and the like.

In some example implementations, alert rules of the receiver **102** may be different from the remote monitor **114**. For example, a different set of rules may define when an alert is sent and/or triggered by to the receiver **102**, when compared to the set of rules used to trigger a notification to the remote monitor **114**. Moreover, although the receiver **102** may trigger alerts on its own (e.g. applying thresholds to sensor data received from sensor system **8**), receive alerts from sensor system **8** or receive alerts directly from the secure server **110**, the remote monitor **114** may be configured to receive messages, such as short messages, text messages, and the like, from a notification service **112**, and these messages can serve to activate the remote monitor **114**, such as activating the remote monitor application of the remote monitor. For example, the remote monitor **114** may close the remote monitor application session (as well as close network connection **109** to secure server **110**), when the remote monitor application is not actively being used to conserve power at the remote monitor. When this is the case, the notification service **112** may send a message over network connection **111** to activate of the remote monitor **114** and/or a remote monitor application (and this activation may be automatic or under the control of a user of remote monitor **114**).

Although some of the examples described herein refer to secure server **110** as an intermediary node between the receiver **102** and the remote monitor **114**, in some example implementations, the secure server **110** may be by-passed. For example, the gateway **104** may communicate directly with the remote monitor **114**, and vice-versa. In addition, the gateway **104** and receiver **102** may receive notification messages to activate an application at the receiver **102** or gateway **104** to allow the host to be alerted.

FIG. **3** depicts an example process **197** for notifying a remote monitor **114** of an event associated with receiver **102**, continuous analyte sensor **10**, delivery pump **2**, glucose meter **4**, and/or host **199**, in accordance with some example implementations. The description of FIG. **3** also refers to FIG. **2**A.

In some example implementations, the secure server **110** may register and/or configure one or more of the receiver **102**, the continuous analyte sensor **10**, the delivery pump **2**, the glucose meter **4**, and the host **199** before process **197** is initiated, although registration and/or configuration may occur at other times as well. The registration process may be performed to register the receiver **102**, the continuous analyte sensor **10**, the delivery pump **2**, the glucose meter **4**, the remote monitor **114**, and/or the host **199** with the secure server **110**. Moreover, the configuration process may be performed to configure system **100** including the identities of the one or more remote monitors used to monitor receiver **102**, configure one or more rules used to trigger notification messages to the remote monitors, configure one or more rules designating primary and secondary remote monitors, configure one or more rules establishing schedules for the primary and secondary monitors, configure one or more rules defining an escalation sequence representative of when to elevate an event to a primary monitor or a secondary monitor, and the like.

At **180**, receiver **102** may send sensor data, such as analyte data from sensor system **8** and the like, to gateway **104**, which then forwards the sensor data at **182** to secure server **110**. For example, receiver **102** may couple to gate-

way **104** via a wired or wireless connection, and gateway **104** may couple to secure server **110** via network **108**A. The gateway **104** may be configured to pull current and/or historical data from the receiver **102** on its own or in response to a request from secure server **110**.

At **186**, the secure server **110** may determine whether one or more of the remote monitors **114**A-**114**M, such as remote monitor **114**A, should be sent a notification message regarding an event. The secure server **110** may determine whether to send a notification message to a remote monitor **114** based on received sensor data (as well as any other data available at the secure server), which triggers an event (or satisfies a rule) at the secure server. For example, secure server **110** may receive the sensor data at **182** and then process the received sensor data alone or along with other data (e.g., historical data, data from other sources of patient information, and the like) to determine whether to send the notification message alerting the remote monitor **114** of the event. The secure server **110** may also receive information from other systems, such as a heath management system or a health care provider's system, and this information may be used to trigger notification messages to the remote monitor. In addition, the secure server **110** may send notification messages to confirm whether the remote monitor is still actively monitoring the host **199**.

To illustrate by way of an example, receiver **102** may receive sensor data from host **199** and transmit the sensor data to secure server **110** via gateway **104** and network **108**A, and the secure server **110** may process the sensor data and determine a glucose level event by comparing the most current glucose level data to a predetermined low glucose threshold, although other events described herein may be detected as well. The secure server **110** may include one or more rules defining events, such as the low level of glucose exceeding a threshold and include rules defining the identities of the remote monitors receiving a notification message indicating the low level of glucose at the host **199**. For example, the rule may define that when a low level of glucose is detected for a certain host, a certain remote monitor should receive a notification message. The notification message may include an indication of the low level of glucose (e.g., the glucose value), the time of the event, and other information, such a plot of current and past glucose levels, host information (e.g., name), and/or any other host related information.

The one or more rules defining the events may be defined during the configuration process by a user, such as host **199**, a caregiver, and/or predefined as default rules (which may be reconfigured by a user or may be adapted by the system **100** over time to accommodate the host). In some example implementations, the one or more rules may define a threshold value representative of a severity of the event that should be reported to the one or more remote monitors, the times of day when a notification message should be sent to each of the remote monitors, the identities (e.g., phone number, Internet Protocol address, email address, and the like) of the one or more remote monitors, and the like.

Furthermore, the one or more rules may include escalation rules, so that events can be handled differently based on severity of event, type of event, and/or lack of responsiveness by a designated remote monitor. For example, a rule may define that a glucose value below a certain value should not be the subject of a notification message to remote monitor **114** (although an alert message may be sent to the receiver **102** or gateway **104** to notify the host **199**); another rule may define that a glucose value between a range of values should be the subject of a notification message to remote monitor **114**; while another rule may define sending, when a dangerously low glucose value is detected, notification messages to remote monitor **114**A as well as other remote monitors **114**B-M. In some example implementations, the rules used to trigger alerts to host **199** at receiver **102** may be different from the rules used to send notification messages to remote monitor **114**, although one or more of the rules may be the same as well.

Although the previous examples described an event associated with low glucose levels, other types of events described herein may be defined as well at the secure server **110** in order to trigger notification messages to the remote monitor **114** and/or trigger alerts to the receiver **102**.

At **187**, the secure server **110** may send an alert to the receiver **102** and/or gateway **104**. The alerts may be triggered based on events which are the same or different as the rules used to trigger events for notification messages to the remote monitor **114**. Moreover, the secure server **110** may include a delay between when the alert is sent at **187** and the notification messages are sent at **188-190**. For example, the delay may allow the receiver **102** to acknowledge or take action before sending messages at **188-190**, as the receiver may also have a set of rules that are the same or different than those for the receiver stored on the secure server. That is, the receiver **102** may trigger an alert based on rules residing within the receiver, and the receiver may receive an alarm from the secure server based on a different set of rules stored at secure server. The delay prior to the secure server **110** sending a notification to the receiver **102** may be varied by the secure server based on the severity or type of event, and the delay may be configured by a user and/or configured programmatically. For example, a first delay may be used for a first low analyte threshold, but no delay may be used for a second, more severe, low glucose threshold.

At **188-190**, a notification message may be sent to one or more remote monitors based on whether one or more rules are triggered at **186**. In some example implementations, the secure server may send a notification message to a push notification service **112**, which then pushes a notification to the remote monitor(s). Examples of push notification services include the Apple Push Notification Service (APNS) and Google Cloud Messaging, although any other messaging mechanism including email, short messaging service, tweets, and the like may be used as well. In the case of APNS, the remote monitor **114** (or a notification message center therein) may establish an Internet Protocol (IP) connection with the APNS. This connection may be encrypted, persistent, and/or accredited, so that the notification service can send notification messages to the notification message center even when the remote monitor application and/or remote monitor are not actively being used. For example, the notification message center may alert the user of the remote monitor **114** that a notification message had arrived for the remote monitor application.

In an implementation utilizing a push notification service, the notification service **112** may receive a notification message from secure server **110**. The notification message may include a destination address, such as a phone number of the remote monitor **114**, an IP address, and the like, and a payload, such as the contents of the notification message. Returning to the previous example regarding low glucose level, the notification message may include the phone number of remote monitor **114** and a short text message, such as a low glucose level value, time of measurement of the value, and/or an identity of the host. The notification message may be limited to 256 bytes, although other sized messages may be used as well. In any case, the notification service **112**

pushes the notification message to remote monitor **114** via a connection, such as an Internet Protocol (IP) connection, between the notification service **112** and a notification message center at the remote monitor **114**. When the notification message center at the remote monitor **114** receives the notification message, the notification message center may display the notification message, generate a sound, a vibration, and another other indication to a user of the remote monitor **114**. And, in some example implementations, the notification message center or a user of the remote monitor may activate the remote monitoring application if the remote monitoring application at the remote monitor **114** is not actively being used. The notification service **112** may be used in implementations in which the remote monitor **114** resides on a device, such as a smart phone and the like, that places the remote monitor **114** or the applications therein in an idle or an inactive mode to conserve power or reduce signaling to/from the network.

In some example implementations, the push notification service may be by-passed, so that the secure server **110** sends the notification message directly to the remote monitor **114** and/or the remote monitoring application therein. This may occur, for example, when the remote monitoring application is open on the remote monitoring device.

When the notification message is received at **192**, the remote monitor **114** or a remote monitoring application therein may be activated if in an idle mode or an inactive mode. Once activated (which can be programmatically or under the control of a user), the remote monitor **114** may attempt to establish a connection to secure server **110**. For example, the remote monitoring application may not be actively being used (e.g., in an idle mode, sleep mode, off, in background mode, and the like). To activate the remote monitoring application, the remote monitoring application may be activated by, for example, opening the remote monitoring application by selecting and expanding the remote monitoring application, actively using the remote monitoring application by entering a value into, selecting an element of the user interface of the remote monitoring application, and the like. Moreover, the remote monitor and/or remote monitoring application may be activated by other ways as well. For example, activation may be invoked by movement of the remote monitor detected by a motion sensor and/or turning on, or increasing the intensity, of the display at the remote monitor.

In response to acknowledgement that the remote monitor **114** has activated the remote monitoring application via access message **194**, the secure server **110** may send at **196** additional information to the remote monitor. The content of the additional information sent from the secure server **110** to the remote monitor **114** may be automatically determined or may be defined by a request from remote monitor, which may be a request included in the access message **194** or a subsequent message from the remote monitor. The additional information may include one or more of the following: all available sensor data not currently stored in the remote monitor **114**, sensor data over a predetermined amount of time, such as the previous 3 or 24 hours of glucose data obtained from the sensor system **100**, receiver **102**, and/or secure server **110**, a plot of the glucose levels over time, a glucose variability value, instructions, motivational messages, status of host, remote monitoring permissions modified by the host, and the like.

In some implementations, the secure server **110** automatically sends sensor data from the past three hours to the remote monitor and the remote monitor can request any additional amount of past sensor data should the remote monitor want to evaluate the host over a longer period of time. The secure server **110** may query the receiver **102** via gateway **104** for additional data in order to respond should the secure server not have all sensor data specified in a request from the remote monitor **114**.

To illustrate further, when the remote monitor **114** receives the notification message, the notification may cause message **132** to appear on a display screen of the remote monitor **114** as depicted in FIG. **2**A. From the message **132**, the remote monitoring application may be activated, either autonomously or under the direction of a user and/or notification message center. The remote monitoring application may then access at **192** the secure server **110** and programmatically receive any additional information associated with the event or other data since the last connection to secure server **110**. For example, once the notification message is acknowledged with an access at **194** or an acknowledgement message, secure server **110** may automatically respond with a page having a trend graph of the current glucose state and information indicating the severity of the event (or any other information available at secure sensor **110**). Although the secure server **100** may instead respond with a subset of the data, in which case, the secure server **110** may automatically respond with new data since the last connection to secure server **110**, so that remote monitor can generate a page including the trend graph showing the last 3 hours' worth of glucose levels. In any case, the remote monitor may be configured to automatically present, when message **196** is received, the page showing relevant event information, such as a trend graph covering a predetermined time period (e.g., a three hour history of glucose levels) for the host. An exemplary page that can be automatically presented is illustrated in FIG. **19**, which is discussed in more detail elsewhere in this disclosure.

Although FIG. **3** is primarily discussed with respect to remote monitor **114** monitoring a single host for ease of understanding, it is understood that the remote monitor may be monitoring multiple hosts, as discussed elsewhere herein. As such, secure server **110** may have sensor data and additional information associated with other hosts. Accordingly, in some implementations secure server can automatically send over sensor data of the other hosts remote monitor is monitoring, along with the sensor data from the host that triggered the notification **190** to the remote monitor. In this manner, remote monitor **114** can have an updated set of sensor data and other information associated with each of the hosts remote monitor is monitoring.

FIGS. **4**A and **4**B depict examples of notification messages **170** and **172**, respectively. In the example of notification message **170**, the notification message **170** may be presented at remote monitor **114** as a window requiring a user interaction, when the remote monitor **114** receives the notification message. For example, the user interaction may comprise pressing a button on remote monitor **114**, touching the screen of remote monitor over the area associated with a portion of the message **170** or activating (e.g., executing, opening, and the like) the remote monitoring application at remote monitor **114**. In some instances, the notification message **170** may appear when another application at remote monitor **114** is actively being used. When this is the case, a user interaction may comprise touching the screen over the area associated with a portion of the message **170** to acknowledge receipt of the notification message **170** before the user is allowed to resume the other application, although the user action may also preempt the other application and make the remote monitoring application the active application being viewed at the remote monitor. Moreover, the

decision of whether to preempt the other application or resume the other application may be predetermined based on the severity level of the event, so that relatively more severe events preempt the other application, while less severe events do not.

In the example of notification message **172**, the notification message **172** may be presented at remote monitor **114** as a message that appears in the user interface as an informational message not requiring intervention on the part of the user. Furthermore, when notification message **172** appears while another application is being used at remote monitor **114**, notification message **172** does not require the user to acknowledge notification message **172**, or even activation of the remote monitoring application (which may be idle or inactive state at remote monitor **114**), resulting thus in the continued use of the other application by the user.

In some implementations, notifications **107**, **172** alert a user that a threshold has been exceeded, but does not provide an analyte value. In this way, the user could be required to open up the monitoring application to view the monitored host's analyte concentration information. A reason for omitting analyte value information is that the notification may not be a current value due to time lag or other system faults. Further, to this end, remote monitoring system **100** can be configured so an analyte concentration value is not displayed even when a user opens the host monitoring application if the analyte concentration older than a predetermined amount, such as 7.5 minutes.

FIG. **2**B depicts another example architecture of remote monitoring system **100**. Referring to FIG. **2**B, the receiver **102** may incorporate the gateway **104** of FIG. **2**A. For example, the receiver **102** may include an interface, such as a radio frequency modem, to network **108**A. To illustrate further, in the example of FIG. **2**B, the receiver **102** may include a smart phone or other processor-based wireless device and provide access to network **108**A and thus secure server **110** via the public land mobile network and other networks (e.g., the Internet).

In addition, while illustrated separately in FIG. **2**B, the secure server **110** may incorporate the notification service **112** or by-pass the notification service **112** in some implementations. In such implementations, the operation of the system at FIG. **2**B may be similar to the process described at FIG. **3** but sensor data **180** may be sent at **180** directly to secure server **110**, and secure server **110** may send a notification message at **188** directly to the remote monitor **114**.

FIG. **2**C depicts yet another example architecture of remote monitoring system **100**. Here, gateway **104** is depicted as a dashed box including separate devices comprising a docking station **103** and a host communication device **105**. Any of the functions for gateway **104** described herein can be divided between the docking station and host communication device in some implementations. For example, docking station **103** may communicate with receiver **102** and host communication device **105** may communicate with the secure server **110**.

In some implementations, the host communication device **105** is a smart phone and the docking station **103** physically, electrically and communicatively couples to receiver **102** to hold, power and communicate with the receiver. In one implementation, the docking station **103** couples to the receiver via a USB connection to both provide power to the receiver **102** and communicate with the receiver **102**. The docking station **103** then communicates with host communication device **105** via wireless communication, e.g. using the Bluetooth® Low-Energy (BLE) protocol, and the host communication device communicates to secure server **110** via network **108**A. Such an implementation including the docking station **103** may be used in the case where receiver **102** and host communication device **105** do not have the capability to communicate directly with one another because, for example, the receiver and host communication device do not use a compatible communication protocol.

In an example of the implementation of FIG. **2**C, the host communication device **105** is a mobile telephone having a host monitoring application downloaded from the Apple App Store, wherein the application configures the mobile telephone to gather information from receiver **102** via docking station **103** and transmit that information to secure server **110**, as well as any other functions described herein associated with gateway **104**.

Before providing additional implementation examples for gateway **104**, networks **108**A-C, secure server **110**, notification service **112**, and remote monitor **114**, the following provides implementation examples for the receiver **102**, continuous analyte sensor **10**, delivery pump **2**, and/or glucose meter **4**.

Referring again to FIGS. **2**A-**2**C, sensor electronics module **12** may, in some example implementations, include electronic circuitry associated with measuring and processing data generated by the continuous analyte sensor **10**. This generated continuous analyte sensor data may also include algorithms, which can be used to process and calibrate the continuous analyte sensor data, although these algorithms may be provided in other ways as well. The sensor electronics module **12** may include hardware, firmware, software, or a combination thereof to provide measurement of levels of the analyte via a continuous analyte sensor, such as a continuous glucose sensor. An example implementation of the sensor electronics module **12** will now be described further with respect to FIG. **5**.

The sensor electronics module **12** may, as noted, couple (e.g., wirelessly and the like) with one or more devices, such as receiver **102** and the like, presenting (and/or alerting) information, such as sensor information transmitted by the sensor electronics module **12** for display at receiver **102**.

As illustrated in FIG. **5**, the receiver **102** may include one or more interfaces, such as machine-to-machine interfaces and user interfaces. For example, the user interfaces may include a variety of interfaces, such as one or more buttons **124**, a liquid crystal display **122**, a vibrator, an audio transducer (e.g., speaker), a backlight, and/or the like. The components that comprise the user interface may provide controls to interact with the user (e.g., the host). One or more buttons may allow, for example, toggle, menu selection, option selection, status selection, yes/no response to on-screen questions, a "turn off" function (e.g., for an alert), a "snooze" function (e.g., for an alert), a reset, and/or the like. The LCD **122** may provide the user with, for example, visual data output. The audio transducer **230** (e.g., speaker) may provide audible signals in response to triggering of certain alerts, such as present and/or predicted hyperglycemic and hypoglycemic conditions. In some example implementations, audible signals may be differentiated by tone, volume, duty cycle, pattern, duration, and/or the like. In some example implementations, the audible signal may be configured to be silenced (e.g., snoozed or turned off) by pressing one or more buttons **224** on the receiver **102** and/or by signaling the sensor electronics module using a button or selection on the receiver.

Although FIGS. **2**A, and **2**B depict example implementations of receiver **102** as a hand-held display device, other form factors may be used as well, such as a relatively small, key fob-like, dongle-like display device, a cellular phone

(e.g., a smart phone, a tablet, and the like), a personal computer **20**, and/or any other user equipment configured to at least present information (e.g., a medicament delivery information, discrete self-monitoring glucose readings, heart rate monitor, caloric intake monitor, and the like).

In some example implementations, the continuous analyte sensor **10** comprises a sensor for detecting and/or measuring analytes, and the continuous analyte sensor **10** may be configured to continuously detect and/or measure analytes as a non-invasive device, a subcutaneous device, a transdermal device, and/or an intravascular device. In some example implementations, the continuous analyte sensor **10** may analyze a plurality of intermittent blood samples, although other analytes may be used as well.

In some example implementations, the continuous analyte sensor **10** may comprise a glucose sensor configured to measure glucose in the blood using one or more measurement techniques, such as enzymatic, chemical, physical, electrochemical, spectrophotometric, polarimetric, calorimetric, iontophoretic, radiometric, immunochemical, and the like. In implementations in which the continuous analyte sensor **10** includes a glucose sensor, the glucose sensor may be comprise any device capable of measuring the concentration of glucose and may use a variety of techniques to measure glucose including invasive, minimally invasive, and non-invasive sensing techniques (e.g., fluorescent monitoring), to provide a data, such as a data stream, indicative of the concentration of glucose in a host. The data stream may be raw data signal, which is converted into a calibrated and/or filtered data stream used to provide a value of glucose to a user, such as a host, or a caretaker (e.g., a parent, a relative, a guardian, a teacher, a doctor, a nurse, or any other individual that has an interest in the wellbeing of the host). Moreover, the continuous analyte sensor **10** may be implanted as at least one of the following types of sensors: an implantable glucose sensor, a transcutaneous glucose sensor, implanted in a host vessel or extracorporeally, a subcutaneous sensor, a refillable subcutaneous sensor, an intravascular sensor.

Although the description herein refers to some implementations that include a continuous analyte sensor **10** comprising a glucose sensor, the continuous analyte sensor **10** may comprise other types of analyte sensors as well. Moreover, although some implementations refer to the glucose sensor as an implantable glucose sensor, other types of devices capable of detecting a concentration of glucose and providing an output signal representative of glucose concentration may be used as well. Furthermore, although the description herein refers to glucose as the analyte being measured, processed, and the like, other analytes may be used instead or as well including, for example, ketone bodies (e.g., acetone, acetoacetic acid and beta hydroxybutyric acid, lactate, etc.), glucagon, Acetyl Co A, triglycerides, fatty acids, intermediaries in the citric acid cycle, choline, insulin, cortisol, testosterone, and the like. In some implementations, other health characteristics of a host are monitored in addition to or instead of analyte monitoring described herein, including, but not limited to heart rate, blood pressure levels, blood oxygen levels, body temperature, caloric intake, medicament delivery and the like.

In one implementation, the sensor system **8** and receiver **102** comprise the DexCom G4® Platinum continuous glucose monitoring system available from DexCom, Inc., and gateway **104** comprises an Apple iPhone® smartphone available from Apple, Inc. with software downloaded thereon to cause the smart phone to perform some or all of the functions of gateway **104** described herein.

FIG. **5** depicts an example of a sensor electronics module **12**, in accordance with some example implementations. The sensor electronics module **12** may include sensor electronics that are configured to process sensor information, such as sensor data. For example, the sensor electronics module may process sensor data into one or more of the following: filtered sensor data (e.g., one or more filtered analyte concentration values), raw sensor data, calibrated sensor data (e.g., one or more calibrated analyte concentration values), rate of change information, trend information, rate of acceleration information, sensor diagnostic information, location information (which may be provided by a location module **269** providing location information, such as global positioning/navigation system information), alarm/alert information, calibration information, smoothing and/or filtering algorithms of sensor data, and/or the like.

In some example implementations, the sensor electronics module **12** may be configured to calibrate the sensor data, and the data storage memory **220** may store the calibrated sensor data points. Moreover, the sensor electronics module **12** may be configured, in some example implementations, to receive wirelessly calibration information from a device, such as receiver **102**, to enable calibration of the sensor data. Furthermore, the sensor electronics module **12** may be configured to perform additional algorithmic processing on the sensor data (e.g., calibrated and/or filtered data and/or other sensor information), and the data storage memory **220** may be configured to store the transformed sensor data and/or sensor diagnostic information associated with the algorithms.

In some example implementations, the sensor electronics module **12** may comprise an application-specific integrated circuit (ASIC) **205** coupled to a user interface **122**. The ASIC **205** may further include a potentiostat **210**, a telemetry module **232** for transmitting data from the sensor electronics module **12** to one or more devices, such receiver **102** and the like, and/or other components for signal processing and data storage (e.g., processor module **214** and data store **220**). Although FIG. **2** depicts ASIC **205**, other types of circuitry may be used as well, including field programmable gate arrays (FPGA), one or more microprocessors configured to provide some (if not all of) the processing performed by the sensor electronics module **12**, analog circuitry, digital circuitry, or a combination thereof.

In the example depicted at FIG. **5**, the potentiostat **210** is coupled to a continuous analyte sensor **10**, such as a glucose sensor, via data line **212** to receive sensor data from the analyte. The potentiostat **210** may also provide via data line **212** a voltage to the continuous analyte sensor **10** to bias the sensor for measurement of a value (e.g., a current and the like) indicative of the analyte concentration in a host (also referred to as the analog portion of the sensor). The potentiostat **210** may have one or more channels (and corresponding one or more data lines **212**), depending on the number of working electrodes at the continuous analyte sensor **10**.

In some example implementations, the potentiostat **210** may include a resistor that translates a current value from the sensor **10** into a voltage value, while in some example implementations, a current-to-frequency converter may also be configured to integrate continuously a measured current value from the sensor **10** using, for example, a charge-counting device. In some example implementations, an analog-to-digital converter may digitize the analog signal from the sensor **10** into so-called "counts" to allow processing by the processor module **214**. The resulting counts may be directly related to the current measured by the poten-

tiostat **210**, which may be directly related to an analyte level, such as a glucose level, in the host.

The telemetry module **232** may be operably connected to processor module **214** and may provide the hardware, firmware, and/or software that enable wireless communication between the sensor electronics module **12** and one or more other devices, such as receiver **102**, display devices, processors, network access devices/gateways, and the like. A variety of wireless radio technologies that can be implemented in the telemetry module **232** include Bluetooth, Bluetooth Low-Energy, the ANT protocol, NFC (near field communications), ZigBee, IEEE 802.11, IEEE 802.16, cellular radio access technologies, radio frequency (RF), infrared (IR), paging network communication, magnetic induction, satellite data communication, spread spectrum communication, frequency hopping communication, near field communications, and/or the like. In some example implementations, the telemetry module **232** comprises a Bluetooth chip, although the Bluetooth technology may also be implemented in a combination of the telemetry module **232** and the processor module **214**. Further, while telemetry module is depicted as part of the ASIC **205** in FIG. **2**, some or all of the telemetry module can be separate from the ASIC in other implementations.

The processor module **214** may control the processing performed by the sensor electronics module **12**. For example, the processor module **214** may be configured to process data (e.g., counts), from the sensor, filter the data, calibrate the data, perform fail-safe checking, and/or the like.

In some example implementations, the processor module **214** may comprise a digital filter, such as for example an infinite impulse response (IIR) or a finite impulse response (FIR) filter. This digital filter may smooth a raw data stream received from sensor **10**, data line **212** and potentiostat **210** (e.g., after the analog-to-digital conversion of the sensor data). Generally, digital filters are programmed to filter data sampled at a predetermined time interval (also referred to as a sample rate). In some example implementations, such as when the potentiostat **210** is configured to measure the analyte (e.g., glucose and the like) at discrete time intervals, these time intervals determine the sampling rate of the digital filter. In some example implementations, the potentiostat **210** is configured to measure continuously the analyte, for example, using a current-to-frequency converter. In these current-to-frequency converter implementations, the processor module **214** may be programmed to request, at predetermined time intervals (acquisition time), digital values from the integrator of the current-to-frequency converter. These digital values obtained by the processor module **214** from the integrator may be averaged over the acquisition time due to the continuity of the current measurement. As such, the acquisition time may be determined by the sampling rate of the digital filter.

The processor module **214** may further include a data generator configured to generate data packages for transmission to devices, such as receiver **102**. Furthermore, the processor module **215** may generate data packets for transmission to these outside sources via telemetry module **232**. In some example implementations, the data packages may, as noted, be customizable and/or may include any available data, such as a time stamp, displayable sensor information, transformed sensor data, an identifier code for the sensor and/or sensor electronics module, raw data, filtered data, calibrated data, rate of change information, trend information, error detection or correction, and/or the like.

The processor module **214** may also include a program memory **216** and other memory **218**. The processor module **214** may be coupled to a communications interface, such as a communication port **238**, and a source of power, such as a battery **234**. Moreover, the battery **234** may be further coupled to a battery charger and/or regulator **236** to provide power to sensor electronics module **12** and/or charge the batteries **234**.

The program memory **216** may be implemented as a semi-static memory for storing data, such as an identifier for a coupled sensor **10** (e.g., a sensor identifier (ID)) and for storing code (also referred to as program code) to configure the ASIC **205** to perform one or more of the operations/functions described herein. For example, the program code may configure processor module **214** to process data streams or counts, filter, calibrate, perform fail-safe checking, and the like.

The memory **218** may also be used to store information. For example, the processor module **214** including memory **218** may be used as the system's cache memory, where temporary storage is provided for recent sensor data received from data line **212** and potentiostat **210**. In some example implementations, the memory may comprise memory storage components, such as read-only memory (ROM), random-access memory (RAM), dynamic-RAM, static-RAM, non-static RAM, easily erasable programmable read only memory (EEPROM), rewritable ROMs, flash memory, and the like.

The data storage memory **220** may be coupled to the processor module **214** and may be configured to store a variety of sensor information. In some example implementations, the data storage memory **220** stores one or more days of continuous analyte sensor data. For example, the data storage memory may store 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, and/or 30 (or more days) of continuous analyte sensor data received from sensor **10** via data line **212**. The stored sensor information may include one or more of the following: a time stamp, raw sensor data (one or more raw analyte concentration values), calibrated data, filtered data, transformed sensor data, location information, and/or any other sensor related or displayable information.

The user interface **222** may include a variety of interfaces, such as one or more buttons **224**, a liquid crystal display (LCD) **226**, a vibrator **228**, an audio transducer (e.g., speaker) **230**, a backlight, and/or the like. The components that comprise the user interface **222** may provide controls to interact with the user (e.g., the host). One or more buttons **224** may allow, for example, toggle, menu selection, option selection, status selection, yes/no response to on-screen questions, a "turn off" function (e.g., for an alert), a "snooze" function (e.g., for an alert), a reset, and/or the like. The LCD **226** may provide the user with, for example, visual data output. The audio transducer **230** (e.g., speaker) may provide audible signals in response to triggering of certain alerts, such as present and/or predicted hyperglycemic and hypoglycemic conditions. In some example implementations, audible signals may be differentiated by tone, volume, duty cycle, pattern, duration, and/or the like. In some example implementations, the audible signal may be configured to be silenced (e.g., snoozed or turned off) by pressing one or more buttons **224** on the sensor electronics module and/or by signaling the sensor electronics module using a button or selection on a display device (e.g., key fob, cell phone, and/or the like).

Although audio and vibratory alerts are described with respect to FIG. **2**, other alerting mechanisms may be used as well. For example, in some example implementations, a

tactile alert is provided including a poking mechanism configured to "poke" the patient in response to one or more alert conditions.

The battery **234** may be operatively connected to the processor module **214** (and possibly other components of the sensor electronics module **12**) and provide the necessary power for the sensor electronics module **12**. In some example implementations, the battery is a Lithium Manganese Dioxide battery, however any appropriately sized and powered battery can be used (e.g., AAA, Nickel-cadmium, Zinc-carbon, Alkaline, Lithium, Nickel-metal hydride, Lithium-ion, Zinc-air, Zinc-mercury oxide, Silver-zinc, or hermetically-sealed). In some example implementations, the battery is rechargeable. In some example implementations, a plurality of batteries can be used to power the system. In yet other implementations, the receiver can be transcutaneously powered via an inductive coupling, for example.

A battery charger and/or regulator **236** may be configured to receive energy from an internal and/or external charger. In some example implementations, a battery regulator (or balancer) **236** regulates the recharging process by bleeding off excess charge current to allow all cells or batteries in the sensor electronics module to be fully charged without overcharging other cells or batteries. In some example implementations, the battery **234** (or batteries) is configured to be charged via an inductive and/or wireless charging pad, although any other charging and/or power mechanism may be used as well.

One or more communication ports **238**, also referred to as external connector(s), may be provided to allow communication with other devices, for example a personal computer (PC) communication (com) port can be provided to enable communication with systems that are separate from, or integral with, the sensor electronics module. The communication port, for example, may comprise a serial (e.g., universal serial bus or "USB") communication port, to communicate with another computer system (e.g., PC, personal digital assistant or "PDA," server, or the like), a dongle with a wireless transceiver coupled to a docking station as described further below, and/or any other interface. The communication port may also be coupled to, or include, a wireless transceiver to allow wireless communications as well. In some example implementations, the sensor electronics module **12** is able to transmit historical data to a PC or other computing device (e.g., a secure server as disclosed herein) for retrospective analysis by a patient and/or physician.

In some continuous analyte sensor systems, an on-skin portion of the sensor electronics may be simplified to minimize complexity and/or size of on-skin electronics, for example, providing only raw, calibrated, and/or filtered data to a display device such as receiver **102** configured to run calibration and other algorithms described above with respect to the sensor electronics module **12**. However, the sensor electronics module **12** may be implemented to execute prospective algorithms used to generate transformed sensor data and/or displayable sensor information, including, for example, algorithms that: evaluate a clinical acceptability of reference and/or sensor data, evaluate calibration data for best calibration based on inclusion criteria, evaluate a quality of the calibration, compare estimated analyte values with time corresponding measured analyte values, analyze a variation of estimated analyte values, evaluate a stability of the sensor and/or sensor data, detect signal artifacts (noise), replace signal artifacts, determine a rate of change and/or trend of the sensor data, perform dynamic and intelligent analyte value estimation, perform diagnostics on the sensor and/or sensor data, set modes of operation, evaluate the data for aberrancies, and/or the like.

Although separate data storage and program memories are shown in FIG. **5**, a variety of configurations may be used as well. For example, one or more memories may be used to provide storage space to support data processing and storage requirements at sensor electronic module **12**.

Although some of the examples noted refer to a continuous analyte sensor **10**, a glucose meter **4**, and pump **2** in communications with sensor electronics module **12** and/or receiver **102**, other devices may be used as well. For example, sensor electronics module **12** and/or receiver **102** may couple (either via wired and/or wireless links) to other sensors, including a glucose sensor, an altimeter, an accelerometer, a temperature sensor, a location module (e.g., a global positioning system processor or other source of location information), a heart rate monitor, a blood pressure monitor, a pulse oximeter, a caloric intake monitor, a medicament delivery device, and the like.

As noted above, the sensor electronics module **12** may generate and transmit, via a wireless or wired medium, a data package to a device, such as receiver **102**, configured to receive, store, forward/retransmit, and/or display sensor data. The sensor electronics module **12** may, as noted, analyze the sensor data from the multiple sensors and determine which sensor data is to be transmitted based on one or more of many characteristics of the host, the receiver **102**, a user of the receiver **102**, a remote monitor **114**, and/or characteristics of the sensor data. Moreover, one or more of the functions and/or components described herein with respect to the sensor system **8** may also or instead be found one or more of the receiver **102**, gateway or secure server **110**, and the one or more of the functions described herein with respect to the receiver **102** may also be found on the sensor system **8**.

Referring again to FIG. **2**A for purposes of illustration, the receiver **102** may forward analyte sensor data, as well as other available data, via wired and/or wireless links to gateway **104**. In some example implementations, the gateway **104** may include a network interface configured as a radio interface, such as a cellular radio interface (e.g., Long Term Evolution and the like), a wireless local area network interface (e.g., Wi-Fi and the like), and/or any other type of wireless or wired interface. For example, the gateway **104** may include at least one processor including a radio frequency subsystem (e.g., a modem). In these wireless examples, when the receiver **102** couples to gateway **104**, the gateway **104** sends analyte sensor data and the like wirelessly to secure server **110** via network **108**A, which may include one or more of an access network, a wireless local area network, a radio access network, a cellular network, the Internet, and/or any other communication mechanism. In some example implementations, gateway **104** may also include a wired connection network **108**A, which further couples to secure server **110**.

Gateway **104** can automatically send sensor analyte data and additional information from receiver **102** in one or more of a plurality of ways. For example, receiver **102** can provide gateway **104** with information without a request from gateway. The information can be provided automatically, such as after the expiration of a timer or upon the generation of a new sensor data point, or can be responsive to user input to receiver **102**. Gateway **104** can then automatically send the information from receiver to secure server **110**. In another example, gateway can automatically request information based upon predetermined rules, such as after the expiration of a timer, such as a 5 minute timer. The information

provided by the receiver **102** can then be automatically sent to secure server **110**. In yet another example, gateway may send a request for information to gateway **104** which then forwards the request to receiver **102**. The receiver **102** can then provide the requested information to gateway, which then forwards the information to secure server **110**. In each of these examples, the information requested can be for specific information (e.g., a specific time period of sensor data) or simply a general request to send information. In the latter case, the receiver **102** can determine what information to send responsive to the request, such as any new sensor data generated by receiver since the receiver last provided information to the server **110**.

FIG. **6** is a block diagram of an implementation of gateway **104**. The gateway **104** can include a power module **302** for charging the receiver **102** when it is coupled to the gateway **104**, a wireless network interface **304** to allow wireless access to network **108**A using a variety of network access technologies, although wired connectivity may also be provided by gateway **104** to network **108**A, processor **414** and computer memory for storing instructions for processor **314** to execute functions of gateway **104** and storing health-related information received from receiver **102**.

Moreover, the gateway **104** can include a receiver interface **306** to provide a wired and/or wireless interface to the receiver **102** in implementations where the receiver is separate from the gateway and the gateway does not include intermediate docking station **103**. For example, receiver interface **306** may include a universal serial bus interface through which receiver **102** can communicate with gateway **104**, secure server **110**, and the like. The universal serial bus may also provide a physical connection for charging the receiver **102**, although wireless charging may be used as well. Furthermore, receiver interface **306** may include a wireless interface, such as Bluetooth, Bluetooth low energy, Zig-bee, Atom, and any other wireless technology, through which receiver **102** can communicate with gateway **104**, secure server **110**, and the like. The gateway **104** may also include a user interface **310**, such as a display, a touch screen display, a key pad, a speaker, a light emitting diode, and the like. For example, one or more light emitting diodes may be used to indicate whether the gateway **104** is properly coupled to the receiver **102**, network **108**A, secure server **110**, and the like, whether the gateway **104** is connected to a power source (e.g., electrical outlet), whether the battery is charged, and the like. The display may also allow presentation of sensor data, alerts, notifications, and the like. For example, a user interface, such as a display, a light emitting diode, and the like, may provide an indication, such as a specific color light emitting diode, a message, and the like, representing that a connection, such as an Internet Protocol connection, a secure tunnel, and the like, has been establish between the gateway **104** and the secure server **110**, so that the user of the gateway **104** recognizes that the receiver is coupled to the so-called "cloud" which includes the secure server **110**.

As discussed above, in some implementations, gateway **104** can comprise a smart phone having a host monitoring application stored thereon that configures the smart phone to perform the functions of gateway **104** described herein.

FIGS. **7**A and **7**B depict an example of the docking station **700**, which can be the docking station **103** described with respect to of FIG. **2**C. FIG. **7**A illustrates a perspective view of the docking station **700** without receiver **102** physically coupled to the docking station, and FIG. **7**B illustrates a front view of docking station with receiver **102** physically coupled to the docking station. Docking station **700** may have a cavity **710** to allow receiver **102** to be slideably inserted and releasably held into the docking station. The docking station **700** may also include a mechanical mechanism to releasably secure the receiver **102** to the docking station (not shown). The mechanism can be a latch assembly or the like. The docking station may electrically couple to the receiver **102** via, for example, an electrical connector, such as a universal serial bus connector, and/or a wireless interface, such as Bluetooth, Bluetooth low-energy, Wi-Fi, and any other wireless technology, and may transmit data received from the receiver **102** to host communication device **105**, secure server **110** or remote monitor **114** using an electrical connector, and/or a wireless interface, such as Bluetooth, Bluetooth low-energy, Wi-Fi, and any other wireless technology.

The docking station **700** may also serve as a repeater and/or amplifier of any alert triggered by the receiver **102** and/or secure server **110**. For example, the docking station **103** may receive an indication of an alert triggered by the receiver **102** from the receiver. The docking station **700** may repeat the alert by, for example, sounding an audible alarm, causing a vibration, and/or lighting a light emitting diode to indicate the alert to a user. Moreover, the receiver **102** may alert using a first alarm, such as a vibration, while the docking station **700** may re-alert using a second type of alarm that is different from the first alarm. For example, the first alarm can be a vibratory alarm and the second alarm can be an audible alarm or vice versa. As another example, the first alarm can be an audible alarm and the second alarm can also be an audible alarm, but the second audible alarm is louder than the first alarm and/or has a different tonal pattern.

In some implementations, the docking station **700** can trigger an alert by physically sensing an alarm from the receiver **102**. For example, the docking station can include a vibratory and/or audible sensor that can sense vibrations or sounds, respectively, emanating from receiver **102**. In this way, the docking station **103** can trigger an alert upon sensing the receiver **102** triggering an alarm while the receiver is docked in the docking station.

Furthermore, the alert settings at the docking station **700** may be the same or different as those at the receiver **102**. For example, alert settings at docking station **700** may be more stringent than those at the receiver **102**. For instance, the receiver **102** may have a low glucose threshold at a value that is greater than a corresponding low glucose threshold at the docking station **700**. The alert settings of the docking station **700** can be user configurable using a user interface of the docking station or a user interface of the host communication device **105**, for example.

Additionally or alternatively, in some implementations the docking station **700** delays triggering an alert that was triggered by receiver **102** to allow the host time to cure the alert prior to the docking station triggering an alarm. Should the host cure the alert prior to the expiration of the delay, then the docking station **700** does not trigger the alert.

Further to FIGS. **7**A and **7**B, the docking station **700** can include one or more light indicators, such as LEDs, that indicate a status of the docking station **700** and/or other components of the system **100**. For example, a first light indicator **712** can indicate (by either turning on or changing color) if the docking station **700** is receiving power from an external power source, a second light indicator **714** can indicate (by turning on, changing color or blinking) if the docking station is paired to host communication device **105**. Other light indicators can be used as well, such as a third light indicator that indicates if the communication channel

between docking station **700** and host communication device **105** and/or secure server **110** is open and successfully transmitting sensor data from receiver **102**.

FIG. **8** depicts another implementation of gateway **104**. In the example of FIG. **8**, the gateway **104** is configured as a dongle, such as a universal serial bus dongle, including universal serial bus connector **392** for coupling to the receiver **102**, a user interface, such as a button **394** for performing a Bluetooth pairing to another device, such as host device **105**, having access to network **108**A, or directly to network **108**A over a Wi-Fi or cellular communication channel. Although the gateway/dongle may be configured for Bluetooth pairing, the gateway/dongle may support connection establishment to the other devices using other radio access technologies, such as Bluetooth low energy, Wi-Fi, Atom, Zig-bee, NFC, and the like. The gateway/dongle depicted at FIG. **8** may also include a light emitting diode **396** for providing an indication of the state of the gateway **104** or receiver **102** (e.g., battery level, glucose level status, whether a user is in a low or high glycemic state, connection status to network, connection status to secure server, and the like). In some example implementations, the gateway at FIG. **8** may include its own rechargeable battery to power the gateway and/or the receiver **102**, although it may rely on the receiver **102** as a power source as well.

In some example implementations, the gateway **104** may, as noted, include a radio frequency interface to allow the data to be automatically uploaded in a compressed format or uncompressed format from the receiver **102** to the secure server **110**, which may be implemented as a so-called "cloud." And, the uploading may occur programmatically—without user intervention—when receiver **102** is in communication with gateway **104**. The gateway **104** may also be configured to gather an identifier of the receiver **102** (or the receiver may automatically provide the identifier without a request for the identifier from the gateway **104**) and provide the identifier to the secure server **110** to allow the secure server **110** to associate the received sensor data with the host **199**, receiver, and any previously provided sensor data stored at secure server **110** (or a repository coupled to secure server **110**) associated with the host. In some implementations, the identifier is the serial number of the receiver **102**, and the receiver automatically sends the identifier along with any sensor data the receiver provides to gateway. In some implementations, the identifier is the serial number of the associated with the sensor electronics **12** and/or sensor system **8**. Moreover, in some example implementations, the gateway **104** may be configured to send data incrementally, i.e., data previously received would not be re-sent to secure server **110** unless requested by secure server **110**. Furthermore, gateway **104** may select between a cellular connection and a Wi-Fi connection based on connection speed, cost, and the like. For example, a free Wi-Fi connection may be selected over a fee-based cellular connection if available. Further, a cellular connection may be used for sending substantially real-time data generated by sensor system **8**, but a Wi-Fi connection used for sending historical data, as it may not be as important for sending historical data in a timely fashion in some implementations.

In some example implementations, the gateway **104**, receiver **102**, sensor system **8**, and remote monitor **114** may be preconfigured, so that when the sensor system **8** and receiver **102** communicatively couple to gateway **104**, the gateway **104** recognizes the sensor system/receiver and/or users thereof. Further, the remote monitor **114** may also be recognized by server **110** to allow remote monitoring of receiver **102** to occur with little (if any) configuration by an end-user/host of receiver **102**. For example, the secure server **110**, gateway **104**, receiver **102**, sensor system **8**, and remote monitor **114** may be preconfigured and preregistered, with little, if any, configuration or registration effort on the part of the host.

Referring again to FIGS. **2**A-**2**C, the network **108**A may include a wireless access network, such as a cellular network, a wireless local area network, and the like. In addition, network **108**A may couple to other networks as well. For example, the gateway **104** may couple to an access network served by a base station or a Wi-Fi access point, which may have backhaul links to other networks including the public land mobile network, the Internet, and the like. Networks **108**B-C may be implemented in a manner that is the same or similar to network **108**A.

The secure server **110** may receive analyte sensor data, store analyte sensor data, process analyte sensor data to detect events and thus allow generation of notifications to remote monitors **114** and/or generation of alerts to receiver **102** and/or gateway **104**, generate pages or reports for display at remote monitor **114**, receiver **102** and/or gateway **104**, allow registration and/or configuration of host **199**, sensor system **8**, receiver **102**, gateway **104** and remote monitor **114**.

In some example implementations, one or more entities may have remote monitors **114**A-**114**M. For example, the secure server **110** may register the identity of the users of remote monitors **114**A-**114**M and a schedule for when each entity performs monitoring. Moreover, one or more of the entities may be configured at the secure server **110** as primary monitors for receiving notifications, while other entities may be configured as backup, secondary monitors for receiving notifications when a primary monitor does not acknowledge, or act on the, notification message sent to a remote monitor **114** according to one or more predefined rules. Furthermore, the secure server **110** may include one or more rules defining when an event results in a notification to one or more of the remote monitor(s) **114**.

The secure server **110** may also provide a cloud-based diabetes data management framework that receives patient-related data from various devices, such as a medical device, a glucose meter, a continuous glucose monitor, a sensor system, a receiver, and/or other devices (e.g., a device providing food consumption, such as carbohydrates, consumed by a host or patient, medicament delivery data, time of day, temperature sensors, exercise/activity sensors, and the like) including any device disclosed herein. Furthermore, the cloud-based diabetes data management system may receive data programmatically with little (or no) intervention on the part of a user. The data received from devices, receivers, source systems, and the like may be in a variety of formats and may be structured or unstructured. For example, the secure server **110** may receive, from sensor system **8** and receiver **102**, raw sensor data, which has been minimally processed or analyzed, and the received data is then formatted, processed (e.g., analyzed), and/or stored in order to enable report generation by secure server **110**. In addition to sensor data, the secure server **110** may also receive data from source systems, such as health care management systems, patient management systems, prescription management systems, electronic medical record systems, personal health record systems, and the like.

In some example implementations, the secure server **110** may check received data for transmission-related errors, data formatting, device-related error codes, validity of the data, duplicate data points, and/or other aspects of the data. Moreover, if out-of-range data points or device errors are

found, the secure server **110** may identify those data points by, for example, flagging those data points, subsequently correcting the identified data points programmatically or by a system administrator, and storing the corrected data points. Moreover, secure server **110** may be configured by a user, such as a clinician, doctor, and the like, to perform additional data processing steps, such as correcting time of day, correcting the date, and analyzing data by specific cohorts, groups, and relationships (e.g., demographics, such as age, city, state, gender, ethnicity, Type I diabetes, Type II diabetes, age of diabetes diagnosis, lab results, prescription drugs being used, self-reported conditions of the patient, diagnosed conditions of the patient, responses to questions posed to patient, and any other metadata representative of the host/patient). Once secure server **110** performs initial data processing (e.g., checks, cleaning, and analysis), the processed data and/or the raw data may be stored at a repository coupled to the secure server **110**.

The processing at secure server **110** may also include associating metadata with the data received from the devices and/or sensors. Examples of metadata include patient information, keys used to encrypt the data, patient accelerometer data, location data (e.g., location of patient or location of patient's clinic), time of day, date, type of device used to generate associated sensor data, and the like. The patient information can include the patient's age, weight, sex, home address and/or any past health-related information, such as whether the patient has been diagnosed as a Type 1 or Type 2 diabetic, high-blood pressure, or as having any other health condition.

The processing may also include one or more of the following: analysis, such as determining one or more descriptive measurements; detecting or predicting events (e.g., a hypoglycemic, a hyperglycemic, and/or any other feature detected in the sensor data); applying pattern detectors to the received sensor data; and generating reports based on received information, such as sensor data, and descriptive measurements of the information including sensor data. The descriptive measurements may include statistics (e.g., median, inner, and outer quartile ranges, mean, sum, n, standard deviation, and coefficients of variation). In some example implementations, secure server **110** may also associate metadata with the data received from the devices, sensors, source system, and/or receivers; determine one or more descriptive measurements, such as statistics (e.g., median, inner and outer quartile ranges, mean, sum, n, and standard deviation); generate reports including descriptive measurements; validating and verifying the integrity of the received data from the devices, sensors, source system, and/or receivers; processing received data based on metadata (e.g., to select certain patients, devices, conditions, diabetic type, and the like), and/or correlating received data from the devices, sensors, source system, and/or receiver, so that the data can be compared and combined for processing including analysis. Moreover, the results of any processing performed by secure server **110** may be used to generate one or more reports, such as graphs, bar graphs, static charts, charts, and the like. Furthermore, the reports and other outputs generated secure server **110** may be provided to receiver **102**, remote monitor **114**, and any other processor via one or more delivery mechanisms.

Secure server **110** may be considered secure in the sense that it keeps private, patient identifiable information and/or restricts access to users registered and thus authorized to use secure server **110**. For example, secure server **110** may receive a request from a device, such as receiver **102** or remote monitor **114**, to perform an action (e.g., provide data, store data, analyze/process data, request a report, request configuration information, request registration, and the like). Before secure server **110** services the request, the secure server **110** may process the request to determine whether the request is authorized and authenticated. For example, an authenticator and authorizer may determine whether the sender of the request is authorized by requiring a user to provide a security credential (e.g., a user identifier, a password, a stored security token, and/or a verification identifier provided by text message, phone, or email) at a user interface presented on a processor, such as receiver **102**, remote monitor **114**, and/or any other computer. If authorized, authenticator and authorizer may authenticate the sender of the request to check whether a security credential associated with sender of the request indicates that the sender is indeed permitted to access a specific resource at system **100** in order to perform the action, such as store (or upload) data at a repository, perform analyze/process data, request report generation, receive alerts, receive notification messages, and the like.

In some example implementations, the secure server **100** may include a pattern detector to perform pattern detection on data, such as sensor data representative of blood glucose data, analytes, and other data as well (e.g., insulin pump data, carbohydrate consumption data, and the like). The pattern detector may detect the pattern and generate an output, which may be provided to a report generator at secure server for generating an alert to receiver **102**, a notification message to remote monitor **114**, and/or a page containing a report.

Moreover, the pattern detector may detect patterns in data/sensor data retrospectively for a predetermined time defined by system **100** and/or a user. For example, the pattern detector may receive input data from a repository coupled to secure server **110**, and the input data may include sensor data representative of glucose concentration data, analytes, and other data as well (e.g., insulin pump data, carbohydrate consumption data, histograms and/or counts, data from a continuous glucose monitor (CGM data), time of day, amount of carbohydrates, other food related information, exercise, awake/sleep timer intervals, medications ingested, and the like). Moreover, the input data may comprise historical data obtained over a timeframe, such as 8 hours, 1 day, 2 days, 7 days, 30 days, and/or any other time period. For example, the input data may comprise counts representative of monitored analyte detection levels (e.g., glucose concentration levels) received and stored at system **100** over a period covering a four-week timeframe.

To further illustrate the pattern detector, patterns can be recognized based on one or more predefined triggers (also referred to as criteria, rules, and filters). Furthermore, the one or more predefined triggers may be variable and adjustable based user input and/or programmatically based on one or more rules at the secure server **110**. And, some types of patterns may be selected, turned off and on, and/or modified by a user, a user's physician, or a user's guardian, although system **100** may select, adjust, and/or otherwise modify triggers programmatically as well.

Some examples of the types of relationships in the input data that can be considered a pattern are one or more of the following: a glucose level that exceeds a target glucose range (which may be defined by a user, a health care provider, secure server **110**, or a combination thereof); a glucose level that is below a target glucose range; a rapid change in glucose level from a low to a high (or vice versa); times of day when a low, a high, an at range, or rapid glucose level event occurs; days when a low, a high, an at range, or

a rapid glucose level event occurs; a hyperglycemic pattern; a hypoglycemic pattern; patterns associated with a time of day or week; a weighted scoring for different patterns based on frequency, a sequence, and a severity; a custom sensitivity of a user; a transition from a hypoglycemic to hyperglycemic pattern; an amount of time spent in a severe event; a combination of glucose change and time information; and/or a pattern of high variability of glucose data. Further, a pattern may be based on a combination of previous pattern data and a currently detected situation, whereby the combined information generates a predictive alert.

Hypoglycemic patterns by time of day may be detected based on events detected by secure server **110**. For example, a pattern may be identified in situations where the user has low glucose concentrations around the same time in the day. Another type of pattern, which may be identified, is a "rebound high" situation. For example, a rebound high may be defined as a situation where a user overcorrects a hypoglycemic event by overly increasing glucose intake, thereby going into a hyperglycemic event. These events may be detected based on one or more predefined triggers.

To further illustrate examples of the patterns, basic patterns may be configured to allow a search for certain patterns in the data, such as values within range, high coefficient of variance, and the like. Each pattern may have one dimension, such as within range, with a separate pattern looking specifically for below range, another looking for low coefficient of variance, and the like. Each pattern may be statistically based and use standard descriptive statistics in the application of pattern matching. Each pattern may be assigned scores for various rules encoded with each pattern, such as is it positive, negative, how important an insight is, and the like. Each pattern may also be assigned a possible set of date ranges for which the pattern is applicable. For example, counting the number of times a high glucose value is followed by a low below range is a pattern that just applies to the full range. However, looking at high levels of variance can apply to a month, a week, a day, an intraday, every other hour, hourly, and combinations thereof. Every pattern may be assigned a minimally acceptable score before it can be considered for display or generation of an alert sent to the receiver **102** (or host **199**) and/or notification message sent to remote monitor **114**. Each pattern (and any associated triggers/rules) may be processed for a set of data for a certain timeframe, and if the pattern is applied and meets certain minimal requirements, then the patterns are ranked according to significance. As such, the ranked patterns may each correspond to an alert sent to the receiver **102** (or host **199**) and/or notification message sent to remote monitor **114** (or a primary monitor or secondary monitor access the remote monitor **114**).

Further to FIG. **1**, host monitoring system **198**A may have a single remote monitor **114**A or a plurality of remote monitors **114**A-**114**M, and the rules associated with when the remote monitors receive alerts and what types of alerts should be sent may be stored at the secure server **110**. For example, first remote monitor **114**A may receive notification messages during the day, while second remote monitor **114**B may receive notification messages at night, although other schedules may be used as well. Additionally or alternatively, first remote monitor **114**A may only receive notifications when server identifies host system **198** to be at a predefined geographic location (using, e.g., geo-location information provided by host system **198**), such as a school, while second remote monitor **114**B receives notifications regardless of the geographic location of the host. As another example, first remote monitor **114**A may have high and low threshold values that trigger an alert to remote monitor **114**A that are different than one or both of the high and low threshold values that trigger an alert to remote monitor **114**B. Moreover, one or more rules may define first remote monitor **114**A as a primary monitor, while second remote monitor **114**B may be defined as a backup or secondary monitor.

The remote monitor **114** may acknowledge a received notification message by activating (e.g., opening, interacting with, accessing, selecting, and the like) the remote monitoring application which causes a message to be sent at **194** (FIG. **3**) to the secure server **110** or responding to a message presented at the user interface of the remote monitor. If the secure server **110** does not receive any form of acknowledgement that the user has seen or otherwise acknowledged the notification message at the remote monitor after a predetermined amount of time (which may depend on the severity or type of the event), the secure server **110** may resend the notification to the remote monitor **114**. In some example implementations, the secure server **110** may receive a message from the notification service **112** that the remote monitor **114**A is out of service or otherwise unreachable, in which case the secure server **110** may resend the notification message to a different remote monitor **114**B. The delay used by the secure server for resending the notification messages may be configured based on the severity or type of the event, and the secure server may also include rules defining a predetermined quantity of unsuccessful resends or predetermined amount of time before escalation to another primary monitor, a secondary/backup monitor, an emergency medical service, and the like. And, this predetermined quantity of unsuccessful resends may also be configured at the secure server to vary based on severity or type of the event or user configured.

In some example implementations, with reference to FIG. **1**, the remote monitor **114** may receive notification messages for a single host monitoring system **198**A or a plurality of host monitoring systems **198**A-**198**N. Furthermore, a page may be generated by secure server **110** and then sent to the one or more remote monitors for presentation at a user interface at each of the remote monitors, although the secure server **110** may instead send the data to the remote monitor **114** to enable page generation at the remote monitor **114**. The page may include a textual and/or a graphical indication of the status of the one or more hosts being monitored. To illustrate, a school nurse may have a remote monitor **114** with a page depicting each of the host monitoring systems **198**A the remote monitor is monitoring. Each remote monitoring system **198**A-**198**N may be associated with a student. In this example, the page may have the status information for each of the students, the most recent notification message for each of the students, a graphical or a textual indication that the student is within limits, or an indication that the student is above limits, and the like. Each student may be associated with a cell (a defined space on the display). As such, the nurse may quickly view the user interface and see the status of each of the students being monitored. A graphical indication may be used to visually convey the overall status of each student in each student's cell. For example, a so-called "smiley" face icon may indicate the student's glucose levels are within limits and a so-called "sad" face icon may indicate the host's glucose levels are of concern because they are above a threshold. Moreover, in some example implementations, the page may be presented on a display, so that a selection (e.g., touch on a touch screen, mouse over, click, etc.) of a cell, notification or face icon results in additional information being provided to the

remote monitor. For example, selecting a cell of a student may cause the remote monitor **114** to access the secure server **110** and then receive additional information, such as one or more of current and prior glucose levels, patient information, and the like, and update the display page or transition to a new display page that displays information about the selected student in more detail (e.g., displaying a trend graph of the student's glucose level over the past three hours). Although the previous example refers to glucose levels and specific types of messages and icons, other types of events, messages, and icons discussed herein may be used to convey the status of a host.

Dashboard

In some example implementations, the page discussed above may be configured as a so-called "dashboard" including dynamic content. For example, the icons for the host-patients requiring the greatest care or attention (e.g., the patients with glycemic levels that are extremely high or low) may be arrange in the top row of page to allow the remote monitor to quickly ascertain the state of riskier host patients. Although the previous arrangement described using the top row of the page to segregate some of the so-called riskier host-patients other segregation schemes may be used (e.g., different colors, intensities, and/or locations on the page). Furthermore, the page may be considered dynamic as the patients segregated for extra attention may change over time causing the page to depict different icons for different patients in the segregated top row of the page. Examples of dashboards are discussed in greater detail with respect to FIGS. **18**A and **18**B.

Designating Remote Monitors

In some example implementations, an entity, such as a user, may be designated by secure server **110** as a primary remote monitor. When this is the case, the primary monitor at remote monitor **114** may not be available due to for example a dead battery of the remote monitoring **114**A, a device out of service, a lack of radio reception, and the like. A secondary remote monitor may thus be designated by secure server **110** to receive the notification message, which would otherwise be sent to the primary monitor. The secondary monitor may have access to another remote monitoring device **114**B and thus receive the notification message, when the first notification message to the primary monitor is not received or acknowledged within a predetermined amount of time. The amount of time can be variable based on the severity or type of event. In addition to monitoring acknowledgements from the remote monitor **114**, the secure server **110** may access the quality of service mechanisms at the notification service **112** to determine whether the remote monitor **114** device is not in service (e.g., due to a failure, a dead battery, out of range, or otherwise not accepting notification messages) to enable the secure server **110** to select another monitor that is in service.

Escalation

The remote monitor **114** may, in some example implementations, generate a message for presentation requiring some form of acknowledgement or action by the user of the remote monitor **114** (e.g., a primary or secondary monitor) to confirm receipt of a notification message. The acknowledgement or action may comprise responding to the notification message, opening a remote monitoring application at the remote monitor **114**, and the like. Moreover, if the action is not performed within a predetermined amount of time, the secure server **110** may determine that the user of the remote monitor has not seen (or otherwise been notified by) the notification message. When this is the case, the secure server may escalate the notification message to another remote monitor as defined by one or more rules at the secure server. The secure server may also check the push notification service (or quality of service mechanism therein) to see if the notification message has been delivered. If not, the secure server may determine that the user of the remote monitor has not seen the notification message and use this as a basis to escalate the notification message to another remote monitor.

In some implementations, the secure server **110** may include one or more rules defining an escalation sequence defining which notification messages should be sent to first remote monitor **114**A and, given an out of service state, when the messages should be resent to one or more other remote monitors **114**B-**114**M. During configuration of the remote monitors **114**A-**114**M, the secure server **110** may be configured via user input (e.g., the host and/or one or more of the remote monitors) how and/or when each of remote monitors **114**A-**114**M is to be notified in an escalation sequence. This escalation sequence configuration may be defined by a user or provided as a default setting (which may be reconfigurable or adaptable over time based on the responsiveness of the user/host/monitor) and may vary based on severity of the event and type of event. For example, the escalation sequence may define rules defining when to alert a host-patient at a receiver **102**, when to escalate to a primary monitor **114**A, when to escalate to a secondary remote monitor **114**B, and/or when to escalate to an emergency medical service or 911-emergency response.

In some example implementations, the escalation rules may be different for each of the remote monitors **114**A-**114**N and/or different from the thresholds set for the host monitoring system **198**. For example, a first rule may define that if a glucose value exceeds a first threshold value, the secure server **110** should send an alert to first remote monitor **114**A. The secure server **110** may include a second, separate rule that defines sending a notification message to a second remote monitor **114**B when the glucose value exceeds a second threshold value, and yet another third rule that defines sending another notification message to a third remote monitor **114**M when the glucose value exceeds a third threshold value. In addition, a rule may define sending a notification to more than one remote monitor, such as all remote monitors or a subset of the remote monitors monitoring a host. The rules may be configured by a user (e.g., using receiver **102**, gateway **104**, workstation **22**, etc.) or provided as default settings (which may be reconfigurable by a user).

Furthermore, if a user at the receiver **102** does not acknowledge an alert within a predetermined amount of time, an escalation sequence may also be implemented. For example, referring to FIG. **2**A, the secure server **110** may determine (e.g., by monitoring sensor data received from receiver **102** and knowing the thresholds on the receiver) that receiver **102** alerted (or should have alerted) host **199**, where the alert required an acknowledgement. The acknowledgement can be in the form of a user responding to a message presented on a user interface **122** of receiver **102**, or the user otherwise curing the alert, such as taking an action that can be measured by a device associated with the host-user (e.g., medicament pump **2** indicating that insulin has been administered to the user, an analyte measurement indicating that the underlying cause of the alert is no longer a problem because measured level above a threshold or trend moving in a desired direction, etc.). In this example, if the secure server **110** does not receive some form of acknowledgement and/or an indication of the underlying event that triggered the alert is cured after waiting a predetermined amount of time, the secure server **110** may resend the alert

and/or send a notification message to a primary remote monitor (e.g. **114**A), a secondary remote monitor (e.g. **114**B), and/or an emergency medical service. And, this escalation, including the retries and delay, may be configured at the secure server **110** to vary based on the severity and/or type of event triggering the alert.

Reminders

In some example implementations, the secure server **110** may include rules providing a so-called "follow-up" reminder. For example, if a host-user at receiver **102** has not taken an action, such as take insulin, drink a glass of juice, etc., the secure server **110** may send a reminder notification to the remote monitor **114** and/or to the receiver **102** and/or gateway **104** after a predetermined amount of time. The predetermined amount of time and which of the one or more of remote monitors **114**A-**114**M, receiver **102**, gateway **104** associated with a reminder may be configurable and may vary based on severity of the event and/or type of event.

Furthermore, in some implementations, the secure server **110** may re-send notifications repeatedly (e.g., every 5 minutes or any other time) to remote monitor **114** and/or receiver **102** until the receipt of the notification message is acknowledged. In some example implementations, the secure server **110** may configure different alarm types to be triggered by the receiving device (e.g., remote monitor **114** or receiver **102**) as each re-send is sent to the receiving device (e.g., successively increasing volume, brightness, or vibration with each repeated, unacknowledged notification message, or triggering a vibratory alarm with a first reminder and a vibratory alarm with a second reminder, etc.). Opening a message from the secure server **110** at receiving device may serve as an acknowledgment, as well as other actions detectable by the secure server.

In some example implementations, a user designated as a primary monitor may signal to secure server **110** an inability to provide monitoring by sending a message to secure server **110** and/or receiver **102**, using, for example, remote monitor **114**A or workstation **22**. When this is the case, the secure server **110** may demote the primary monitor to a secondary (or backup monitor) and promote one of the secondary monitors to a primary monitor. The secure server may have rules defining which of the secondary monitors may be promoted or each of the secondary remote monitors may be polled to assess availability to assume the role of primary remote monitor. And, the secure server **110** may send a message (via notification service, for example) to the secondary monitor that has been promoted to a primary monitor that it has been designated as a primary monitor (and send a corresponding message to a demoted primary monitor).

To assure quality of service with respect to the receipt by the remote monitors of notification messages, one or more operations may be performed to mitigate the potential loss of a notification message sent to remote monitor **114**. For example, if notification service **112** comprises a push notification service (e.g., Apple Push Notification Server, Google Cloud Messaging Server, and the like) and the notification service cannot be contacted (or a connection cannot be established between secure server **110** and notification service **112**), the secure server **110** may send notification via another mechanism, such a separate a short message service (SMS) message directly to the remote monitor **114**, a phone call, an email, or any other mechanism to establish contact with the remote monitor(s) and/or the users associated with those remote monitoring devices.

Registration/Invitations for Remote Monitoring

As noted above, in some example implementations, the devices used at system **100** may be required to register with the secure server **110**. To illustrate, with respect to FIG. **2**B, the receiver **102** (which may be implemented on a processor-based wireless device, such as a smart phone or a tablet computer) may send a message via the public land mobile network or other network(s) to invite remote monitor **114** to accept a connection establishment request from secure server **110**. If accepted, remote monitor **114** may be provided with notification messages for events associated with receiver **102** and access to sensor data and reports associated with host **199**. Although the previous example describes the receiver **102** sending an invite to remote monitor **114**, other devices, such as secure server **110**, gateway **104**, user communication device **105**, workstation **22**, and/or remote monitor **114**, may send invitations as well or instead, depending upon the implementation.

In some example implementations, the receiver **102** may send a plurality of invitations to each of a plurality of remote monitors **114**A-**114**M. Moreover, the invitations may be managed by the receiver **102**, gateway **104**, user communication device **105** and/or secure server **110**, so that at any given instant of time, a user can monitor the status of invitations, such as how many invitations have been sent, how many have been accepted, how many have been rejected, and the identity of any primary and secondary remote monitors. For example, receiver **102** gateway **104**, user communication device **105** and/or secure server **110** may manage the invitations, so that at any given instant, a quantity of remote monitors **114**A-**114**M does not exceed a threshold amount (e.g., 5 or 10 remote monitors).

Moreover, the receiver **102**, gateway **104**, user communication device **105** and/or secure server **110** may also manage the quantity of remote **114** monitors based on location and/or time, so that a host-user has a predetermined quantity of remote monitors **114** at any given location and/or any given time.

In some example implementations, a host **199** or caretaker of host may manage the status of invitations (e.g., invitation sent, invitation accepted, monitoring cancelled, and the like) via receiver **102**, gateway **104**, user communication device **105** and/or secure server **110**. For example, one or more user-interactive pages may be presented on a computer display (e.g., of receiver **102**, gateway **104**, user communication device **105**, or workstation **22**, etc.) including the status of the invitations (e.g., whether invitation pending, denied, or accepted). These one or more pages may be configured to allow changes to the rules associated with the remote monitors **114**A-**114**M. For example, changes may be made to the rules used to trigger notification messages, the designation of primary monitors (including time and location designations), the designation of secondary monitors (including time and location designations), the escalation sequence and escalation threshold settings, and the like. In addition, the page(s) may provide a list of remote monitors from which a user can designate primary and secondary remote monitors and send invitations to any selected monitors. The page(s) may allow configuration of permissions, such as whether a remote monitor **114** is authorized to receive one or more of notification messages, authorized to view patient data (e.g., sensor data including current and/or past data), and the like.

FIG. **12** depicts an example invitation page **500** presented at a remote monitor **114** in the form of an email message. In this example, a user, "John Doe," associated with a sensor system **8** and receiver **102** has invited remote monitor **114** to be a monitor as indicated by the invitation at **502**. Moreover, the invitation may include instructions for the remoter monitor, which in this example includes clicking on a link at

504 to allow a download of the remote monitor application code from secure server 110 or another server (e.g., iTunes server operated by Apple, Inc.) and accepting the invite at 506 (which sends an acceptance message to secure server 110). The remote monitor may also be given the option to not accept the invitation to monitor by selecting a user-selectable decline icon 508, which may notify secure server 110 of the decline indication.

In some implementations, to register an invited remote monitor 114 with the secure server 110, the remote monitor and the receiver 102 may each input a value, such as a code, a shared secret, a link (e.g., a uniform resource locator), a password, or a combination thereof, to allow connection establishment and thus enabling remote monitor 114 to receive notification messages for events associated with receiver 102 and to have access to sensor data and reports at secure server 110. Moreover, a user, such as host 199, may access an Internet browser using workstation 22 of FIG. 1, for example, to access secure server 110 and login to view and manage the one or more devices granted remote monitoring privileges.

Connection establishment refers to the process of adding one or more remote monitors to system 100 to provide a second layer of oversight into the operation of sensor system 8 and receiver 102. The connections to the remote monitor 114 may be established based on an invitation sent to the remote monitor 114. This invitation may be sent with the consent of the receiver 102, gateway 104 (e.g., via a user interface therein), and/or host 199. For example, the receiver 102 and remote monitor 114 may be required to both accept invitations or to enter a code (e.g., a password, shared secret, and the like) in order to opt in to the remote monitoring provided at system 100.

In some example implementations, one or more of the devices of remote monitoring system 100 (e.g., remote monitor 114, receiver 102, gateway 104, user communication device 105, or workstation 22) may need a code, such a prescription code provided by a health care provider, in order to register with secure server 110. The code may expire after a predetermined time and/or may be limited to a predetermined number of uses (e.g., a single use code that can be used once to register with secure server 110 to obtain a remote monitor code). Furthermore, the code may also define at the server 110 a configuration for the device being registered as a remote monitor 114, such as permissions (e.g., whether can receive notifications, view past sensor data and/or view current sensor data) of and/or alert settings associated with the remote monitor.

In some example implementations, the secure server 110 may have configuration information defining the identity of the receiver 102 and remote monitor 114, so that a user, such as host 199, may access secure server 110 and then add one or more devices, such as receiver 102 and remote monitor 114 to the user's system. The remote monitor 114 may query secure server 110 to obtain information regarding which hosts (or receivers) the remote monitor is allowed to monitor and the secure server can configure the remote monitor 114 accordingly. In some example implementations, the notification messages sent to the remote monitor(s) may be configured to suit the needs of a given remote monitor-user and these needs may be different from the needs of the host-patient. Accordingly, the rules dictating the sending of a notification message to remote monitor 114 may be different from a rule used to trigger an alert to the receiver 102 being used by the host-patient.

The following provides an illustrative example of a caregiver using remote monitor 114 as part of host-patient care with reference to FIG. 2A. Specifically, the caregiver may be administering an analyte therapy to the host-patient. For example, the caregiver may be a parent of a young child. In this example, a parent may want to receive notification messages, which are identical to the alerts, sent to the receiver 102 (or triggered by the receiver) and host-patient (which in this example is a child). Moreover, the secure server 110 may obtain the receiver 102 settings through the gateway 104. During the configuration of the remote monitor 114, the secure server 110 may prompt the parent to select a set of rules that are identical to those being used by the child's receiver. In this example, any subsequent changes made to the set of rules being used for the child's receiver would be programmatically propagated to the set of rules being used to send notifications to the parent's remote monitor 114. Although the previous example described the same set of rules being used from the host and monitor, the host and monitor may implement different rules as well.

The following provides another illustrative example of a host-patient administering treatment but in this case, the host-patient or caregiver may not want a high degree of oversight of the host-patient. To that end, the caregiver at remote monitor 114 may want the host-patient to receive an alert first, but allow the patient-host time to act on the alert to correct or acknowledge the event prior to an alert being sent to the caregiver. As an example, an alert triggered by the receiver 102 may indicate a hypoglycemic or hyperglycemic event, and if after a certain period of time the host-patient has not taken one or more predetermined action(s) to remediate the event (as evident by subsequent glucose measurement indicating the same or worsening patient state, for example), the caregiver at remote monitor 114 may receive a notification message responsive to the event. That is, if a patient-host using receiver 102 does not respond or acknowledge an alert in a predetermined manner, the caregiver at remote monitor 114 may then receive a notification message. The caregiver at remote monitor 114 may thus receive a notification message when the host patient at receiver 102 fails to respond to, or acknowledge, certain, real time events, such as a low glucose event (which may be considered severe as the host-patient may be incapacitated or unaware of the event so a notification to the remote monitor is in order). However, the secure server 110 either delays sending reminders or stops sending reminders responsive to a notification message if one or more predetermined occurrences are identified by the secure server. The one or more predefined occurrences can be curing the underlying event triggering the alert, acknowledging the alert or taking a defined action, such as administering insulin and the like.

Further, the secure server 110 may be configured with a delay to wait for an acknowledgement or action before notifying the remote monitor 114, and this delay may vary based on the type and/or severity of the condition causing the alarm, and vary depending upon default or user configured settings of the remote monitor. In addition, the secure server 110 may be configured to also monitor data from the receiver 102 even after an acknowledgement message is received from the receiver 102 in response to an alert. For example, the secure server 110 may receive the acknowledgement message (which may be a message sent by receiver 102), but secure server 110 may wait a predetermined time for sensor data from the receiver 102 confirming that the host-patient has indeed taken action. Again, this delay may vary based on the type and/or severity of the condition causing the alarm.

The following provides yet another illustrative example of a host-patient administering treatment but in this case, the host-patient is highly independent so the remote monitor may only be triggered in an emergency. For example, the secure server **110** may include a rule to trigger a remote monitor in the case of an emergency, such as a severe hypoglycemia event occurring at night. In this scenario, the host-patient may not be able to respond to the alert of the event, so the secure server **110** may trigger a notification message if the glucose falls to an extremely low level for a period of time or the user does not respond after a period of time to the very low glucose alert sent to receiver **102**. And, the period of time may be varied based on the type and/or severity of the condition causing the alarm.

The following provides another illustrative example of a host-patient that is highly independent but is hypoglycemia unaware and has no trusted sources for emergency response. In this use case, the host-patient may select a remote monitor **114** associated with an emergency medical service so as to automatically notify the service in the event of a severe hypoglycemic event when the glucose falls to an extremely low level for a period of time or the user does not respond after a period of time to the very low glucose triggered by receiver **102**.

Managing Remote Monitor Alert Settings

In some example implementations, a user may manage the alerts for each of remote monitors **114**A-**114**M monitoring a host **199**. For example, the host **199** can use host monitoring system **198**A to invite remote monitor **114**A to be a monitor and configure the permissions at secure server **114** using receiver **102**, gateway **104** (including host communication device), or workstation **22**. The permission may be specific to one or more certain alerts or global in the sense that all the alerts for remote monitor **114**A may be manipulated by the user. Although the previous example describes the permissions being set by a user, the permissions may be determined programmatically as well.

To manage alerts, a user may access secure server **110** using a computing device, such as remote monitor **114**, receiver **102**, gateway **104**, host communication device **105** or workstation **22**, and manage the alerts by for example setting alerts, changing thresholds, turning alerts on or off, and the like. FIG. **13** depicts an example page **600** that may be presented on a display of the host computing device. The page **600** may allow changes to alerts for a certain remote monitor **114**A. In the example of FIG. **6**, a low glucose alarm **602** may be turned on **610**, and the threshold **604** that defines the threshold configured by the user. FIG. **6** also depicts that delay **606** may be managed using page **600** as well. For example, the delay **606** may define how long the secure server **110** waits before sending a notification message from the secure server (via notification service) to the remote monitor **114**A if the host's glucose concentration remains below the low threshold. In this example, the delay is zero seconds, but can be changed using page **600** to be another amount of time, such as 5, 10, 15 or 30 minutes, or an hour. Page **600** also allows secure server **110** and/or notification service **112** to trigger sending reminders **612** and vary a time **606** associated with triggering the reminders. For example, the reminders represent the amount of time that elapses before the secure server **110** triggers another notification to remote monitor **114**A if remote monitor has not acknowledged the alert or if the host has not cured the event that originally triggered the alert. In this example, if a user fails to acknowledge an alert or take corrective action within 30 minutes after an original notification responsive to a reading below 70 mg/dl, the secure server **110** sends another notification regarding the low glucose level to the remote monitor **114**A. Although the example described with respect to FIG. **6** refers to a low glucose value, a delay, and a reminder, any other aspect of the alerts for a remote monitor **114** described elsewhere herein can be likewise managed as well, such as high glucose level alerts, high rate of change alerts and the like.

In addition, while the above description with respect to FIG. **6** refers to managing alerts for a remote monitor **114**, a similar page can be used by receiver **102**, gateway **104** or host communication device **105** to manage alerts triggered by host communication device in the implementations of FIGS. **2**A-**2**C. As an example, host communication device **105** can display page **600** for managing alerts by host communication device independent from receiver **102**. In this way, host communication device **105** can function as a secondary alert device for host **199**.

In some implementations, a user may modify one or more rules defining alerts representative of events associated with the analyte state of the host. A user may use a computing device, such as remote monitor **114**, receiver **102**, gateway **104**, host communication device **105**, or workstation **22**, to modify the alert settings, such as low glucose level thresholds and the like, of the host monitoring system **198**. In this way, a parent, for example, can modify the settings of their child's remote monitoring system **198**.

Although the previous example refers to modifying low glucose alarms, the modification may include varying a first threshold associated with a low level of glucose at the host, varying a second threshold associated with a high level of glucose at the host, varying a delay between when the message is triggered by the receiver **102**, varying a time value between when a reminder message is sent, and any other alert that may be triggered for a host monitoring system **198** or remote monitor **114**.

Moreover, the secure server **110** may adapt the set of rules associated with a host **199**. For example, the set of rules for a remote monitor **114** monitoring host **199** may be predetermined based on some basic host-patient demographics. After initial use of remote monitoring system **100**, secure server **110** may programically adjust thresholds used to trigger some or all events. These adjustments may be made for a variety of reasons. For example, thresholds, such as glucose levels, glucose rates of changes, and the like, used to determine when to trigger an event may be adjusted to reduce the frequency of some alerts and/or notifications as a remote monitor **114** receiving too many messages may decide to ignore the messages. The thresholds may also be adjusted to tighten the range of a patient's glucose variation during the day in order to decrease the variability in a host's day-to-day glucose variability.

In some example implementations, data management tools and CGM analyses may be used to help patients better manage their diabetes or assist clinicians in enhancing recommendations. As glucose data (and/or other analyte data) may be provided to secure server **110** in about real time, the data may be used by case managers in payer systems and/or medical systems to enhance ongoing diabetes management. However, it may be impractical for a diabetes case manager to review the resulting so-called "big data." As such, filters may be used to allow exception based reporting of use or glycemic patterns to promote efficient use of the case manager's time by identifying specific issues. To that end, one or more patterns may be defined at the secure server to identify the issues requiring the attention of the case manager. The patterns may include longitudinal analysis or comparisons between time periods. These patterns

may also identify high-risk patients, such as those with frequent or severe lows, frequent or severe highs, and/or marked glucose variability. This may be considered particularly important for use with patients on intensive insulin therapy, with hypoglycemia unawareness, poor control, those new to insulin, and the like. The patterns may also identify therapy non-responders identifying, such as those with sustained hyperglycemia, suggesting non-response to therapy or worsening of control, suggesting non-adherence, disease progression, or tachyphylaxis. This may be considered particularly useful when new medicaments are added or therapy is optimized. The patterns may also identify responders or non-responders linked to diabetes education or by particular providers or consultants.

In some example implementations, additional performance information may be gathered at the secure server **110** from patients at a plurality of locations. This additional information may be used to evaluate environmental factors that could influence and affect the sensor's performance. Rather than gathering and analyzing information solely from a single host-patient, data may be gathered at the secure server and then compared on a macro level spanning across a plurality of host patients and/or across a plurality of geographic locations (or regions). In essence, the sensor system's **8** overall effectiveness may be evaluated based upon various environmental factors being monitored. For example, data gathered in real time from across the United States or even the World may show if temperature, humidity, altitude, or the like influence the sensor system's **8** performance and thus provide an indication as to whether the sensor system **8** and/or sensor **10** should be replaced or repaired. Moreover, the secure server **110** may also process received sensor information and identify patterns (e.g., by lot number, region, or the like), and additional algorithms, calibration information or fail-safes may be uploaded based on these identified patterns to improve the sensor accuracy and/or performance.

In some example implementations, the secure server **110** may programmatically track product performance and utilization of a sensor system including sensor **8** and/or receiver **102**. For example, the sensor system and/or receiver may programmatically provide to secure server **110** information identifying the sensor (e.g., lot number) and summarizing its performance. The performance metrics may include accuracy, on time, data capture, and the like. Moreover, if one or more sensor performance metrics fall outside of an expected range, then secure server **110** may request additional information to be transmitted from the sensor system/receiver to the secure server to allow classification of the failure mode. For example, the secure server **110** may send alerts and/or notifications to receiver **102**, gateway **104** and/or remote monitor **114** that the sensor system **8** and/or receiver **102** needs to be maintained (e.g., replaced, repaired, calibrated, and the like) based on determined performance information. And, the secure server **110** may also be configured to send, based on the performance information, alerts or notification messages indicating that the sensors requires a reset, a new calibration value is needed, or a new sensor should be ordered. The data provided to the secure server **110** may be configurable and stored at a repository coupled to the secure server **110**.

Moreover, sensor system tracking by the secure server may include tracking the performance of the receiver's wireless interface. For example, if a hardware error (or any detected error condition) occurs, information related to the error may be transmitted to the secure server **110**. The data transmitted may also be used to track feature utilization, which may include alert settings, number of screen visits, and the like. In addition, this data may be used to collect and manage data during clinical studies. Furthermore, the sensor data transmitted to the secure server **110** may also be expanded to tracking of patient performance of glycemic control. When this is the case, performance metrics may include the "time spent" in different glucose ranges, amplitudes of glycemic excursions, insulin dose information, and the like. For example, during a continuous glucose monitoring (CGM) session, data may be automatically transmitted to a secure server **110** and/or a coupled repository accessible to the host-patient and/or the patient's clinical care provider. Accordingly, the above-noted automatic tracking of product performance and classification of failure modes may, in some example implementations, provide more accurate information regarding product performance, facilitate resolving sensor issues experienced by patients, and automate product replacement (or shipment) when the sensor performance is deemed ready for replacement.

In some example implementations, the secure server **110** may provide a closed control loop. Specifically, secure server **110** may send a message to receiver **102**, which responds to secure server **110**. Moreover, secure server **110** may send messages to remote monitor **114**, which responds to secure server **110**. Accordingly, secure server **110** may request an action from receiver **102** and/or remote monitor **114**, and receive acknowledgement from receiver **102** and/or remote monitor **114**, when the action is completed, forming thus a closed loop. The receiver **102** may include one or more aspects of the functions provided by the remote monitor **114**, and remote monitor **114** may include one or more aspects of the functions provided by the receiver **102**.

Example Host Monitoring System Set-Up Process **1000**

FIG. **10** is a flow chart depicting process **1000** for setting up host monitoring system **198** in accordance with some implementations. For illustrative purposes, the setup process **1000** will be discussed with reference to the remote monitoring system architecture illustrated in FIG. **2**C, although it is understood that setup process **1000** can be applied to the architecture of FIG. **2**A or FIG. **2**B with changes to accommodate the differences of architectures.

Additionally, for further ease of understanding, the following components of FIG. **2**C are used in one example of process **1000**: the sensor system **8** and receiver **102** make comprise a DexCom G4 Platinum continuous monitoring system, available from DexCom, Inc., where the sensor **10** is a DexCom G4 Platinum sensor, the sensor electronics module **12** is a DexCom G4 Platinum transmitter, and the receiver is the DexCom G4 Platinum receiver; the receiver **102** is docked in the docking station **103** as illustrated and discussed with reference to FIG. **7**B; the host communication device **105** comprises an Apple iPhone available from Apple, Inc.; and each remote monitor **114**A-**114**M comprises an Apple iPhone or other mobile phone having an iOS® (commercially manufactured by Apple, Inc.), Android® (commercially manufactured by Google, Inc.) or Windows® (manufactured by Microsoft, Inc.) based mobile operating system.

At block **1000**, a user downloads a host monitoring application on to the host communication device **105**. (It is understood the host monitoring application can be downloaded onto gateway **104** in the implementation of FIG. **2**A or downloaded onto receiver **102** in the implementation of FIG. **2**B the host monitoring application can be, for example.) In some implementations, the host monitoring application is downloaded from a server, which can be independent (e.g., operated by a different entity) of secure

server **110**, such as the Apple App Store server operated by Apple, Inc. However, in some implementations, the host monitoring application is downloaded from server **110**. The host monitoring application can comprise instructions for the host communication device **105** to perform the host communication device functions described herein, such as gathering sensor data from the receiver **102** via the docking station **103**, transmit the sensor data to the secure server **110**, manage alerts of host monitoring system **198**, inviting users to become remote monitors of host, manage remote monitor settings, pairing with the docking station **103** and/or receiver **102**, and the like.

Once the host monitoring application is downloaded to the host communication device **105**, a user can open the application (e.g., by selecting an icon associated with the host monitoring application on a home screen of the host communication device) and use the application to create an account at block **1012**. In addition to storing account information on the host communication device **105**, the account is created and stored on secure server **110**. In some implementations, creating the account includes entering user identifying information, such as name and email address, a password, and a unique identifier associated with the receiver **102**, such as the receiver's serial number, or the sensor system **18**, such as the serial number of sensor electronics **12**. As discussed below in block **1016**, the receiver's serial number or sensor electronics' serial number can be used for pairing the receiver **102** and/or docking station **103** with the host communication device **105**, as well as other functions.

FIG. **9** illustrates an exemplary page **900** host monitoring application can display to a user at the account setup block **1012** to facilitate entry of a unique identifier, such as the serial number of the receiver **102**, the serial number of the sensor electronics **12** or other identifier associated with host monitoring system **198**. Here, the page **900** is an illustration of the location of the serial number to aid the user in finding the serial number of entry, which is a serial number on receiver **102** in this example. Page **900** also provides an alphanumeric entry field the user can select to manually enter the serial number. In addition, page **900** provides selectable icons **902** and **904** that allow the user to take a photo of the serial number using a camera of the host communication device **105** and scan in the serial number using a bar code scanner of the host communication device **105**, respectively, for entry of the serial number.

At block **1014**, the user uses the host monitoring application to manage alert settings for the host communication device **105**. The host application can initially present default alert settings, where the user can modify the default user settings using the user interface of the host communication device **105**. In some implementations, the alert settings comprise repeating one or more alerts on the receiver **102**. This way, the host communication device **105** can amplify (e.g., trigger a different type of alarm than the receiver, such as a louder alarm) and/or echo alarms of the receiver (e.g., only sounding the alarm after a predetermined amount of time from the alarm of the receiver if the event triggering the alert on the receiver has not been cured). The alert settings can also include turning off or on alerts for various events.

The user pairs the host communication device **105** with the docking station **103** at block **1016**. In some implementations, to pair the host communication device **105** with the docking station **103**, the user powers on the docking station and connects the receiver **102** to the docking station. At this point, the host communication device **105** and the docking station **103** begin a pairing and authentication procedure.

In some implementations, the docking station **103** does not have a display and thus conventional pairing and authentication procedures may not be adequate. Thus in some implementations, receiver **102** provides a serial number stored in memory of the receiver to the docking station **103** and a user enters the receiver serial number into the host communication device **105**. The serial number stored in memory of the receiver **102** can be stored during manufacturing of the receiver. The host communication device **105** can then transmit the serial number (or encrypted version of the serial number) to the docking station to establish an authenticated communication channel.

The following pairing and authentication procedure may be used in some implementations. In response to the receiver **102** being docked to the docking station **103**, the docking station derives an authentication token from the receiver's serial number (which the receiver transmits to the docking station automatically upon docking) and puts it in a Generic Attribute Profile (GATT) characteristic. The docking station **103** then broadcasts a general advertisement to bond. The host communication device **105** device looks for the advertisement. After discovering the docking station **103**, the host communication device **105** connects and performs a service discovery. The host communication device **105** then attempts to read the GATT characteristic mentioned previously. The docking station **103** responds with an insufficient authorization message (pairing and encryption is required). The host communication device **105** then prompts the user to pair with the docking station **103**. Both the docking station **103** and the host communication device **105** compromise a long term key to use for encryption and are then paired. The host communication device **105** then reads the token from the characteristic mentioned above, and using this characteristic, verifies the authenticity of the docking station **103**. The host communication device **105**, which has previously derived its own token from the receiver serial number entered previously into the host communication device in block **1012**, writes this token to a GATT characteristic in the docking station **103**. The docking station **103** then uses this token to verify the authenticity of the host communication device and, if authentic, enters a persistent bonded state.

In some implementations, using the above-mentioned pairing and authentication process, if the two devices (receiver **102** and docking station **103**) are disconnected at any point, the docking station **103** directs an advertisement for connection.

It should also be understood that paring process **1016** is described with respect to receiver **102** and docking station **103** as exemplary only. One or more steps in process **1016** can be omitted or modified to allow the pairing process **1016** to work between other components, such as receiver **102** and gateway **104** of FIG. **2**A.

At block **1018**, the user uses the application on the host device **105** to invite remote monitors **114**. Here, the application may prompt the user for identifying information of a potential user of a remote monitor, including a name and email address accessible from a device capable of being a remote monitor **114**, such as a mobile smart phone or tablet computer. In addition, the application can prompt the user for permissions that the user wants the remote monitor **114** to have, such as permission to view trend graph data, and alert settings that the user wants the remote monitor **114** to have. Once finished, the application sends an invitation to the remote monitor **114**, with the information in the invitation, such as identifying information, permissions and alert settings stored on secure sever **110**. The user can invite

additional remote monitors using the above described invitation procedure. In some implementations, the application can include a page that lists the status of all invitations sent by the user.

Note that process **1000** can be implemented using a setup wizard implemented by the host monitoring application on host monitoring device **105** to guide the user through the setup process **1000**.

Further, in some implementations where a serial number or other number associated with a component is used as a unique identifier, the serial number can be printed or otherwise provided on the component using invisible ink. As used herein, invisible ink means a material that can be printed on a surface that is invisible to the human eye, but can be optically detected using a computing device, such as a smart phone employing optical detection using the smart phone's camera. A user can then use a device having optical recognition capabilities, such as a smart phone, to take a picture of the component and the device can automatically recognize the serial number and use the serial number for any of the functions described herein associated with using a unique identifier. In this way, the serial number is not apparent to other people, providing discretion and security.

Further, in some implementations where invisible ink is not utilized, it may be desirable to place the unique identifier on a portion of the system that is hidden from the user when the system is in use, such as on the bottom of sensor electronics **12**, so that the serial number is also not viewable from a third party. This can also result in difficulty for the user should the user need the serial number while the system **198** is in use. Using invisible ink in the above-described manner, however, can solve this problem: the serial number need not be placed on an inaccessible portion of the system **198** because others will not be able to view the number.

Example of Remote Monitor Set-Up Process **1600**

FIG. **16** is a flowchart of an exemplary process of remote monitoring using remote monitor **114**. Similar to process **1000**, FIG. **16** will be described for illustrative purposes only with respect to the remote monitoring system **100** architecture of FIG. **2**C.

At block **1610**, a user receives on a computing device, such as a smart mobile phone, an invitation to become a remote monitor. An example invitation is illustrated and discussed in more detail with respect to FIG. **12**. In some implementations, a user receiving the invitation can either accept or deny the invitation by selecting an accept icon or deny icon, respectively, in the email. Denying the invitation ends process **1600**, whereas accepting the invitation moves process **1600** to block **1620**.

At block **1620**, the invitation programically directs the user via the user's computing device to download a remote monitoring application, if the user accepts the invitation. In some implementations, accepting the invitation at block **1610** programically triggers the user's computing device to automatically access a server carrying the remote monitoring application. The server can be the App Store operated by Apple, Inc. in the case that the user's device is an Apple mobile device. The user then downloads the remote monitoring application onto the computing device.

Note that in some implementations, the user of the remote monitor **114** need not register with secure server **110**, as in certain implementations the secure server already has the user's account information from when the invitation was formed in block **1012** of process **1000** (FIG. **10**).

At block **1630**, the user manages alert settings using the remote monitoring application downloaded on the computing device (now considered a remote monitor **114**). The alert settings can initially be set at recommended alert settings set by the person that sent the invitation at step **1012** in process **1000** (or default settings in the case the person sending the invitation did not enter any recommended settings) in some implementations. The user of the remote monitor **114** can then modify any of the recommended or default settings. The settings can include setting threshold values for when to trigger an alert to the remote monitor, delays, reminders and no data alert settings, discussed in more detail elsewhere herein. The remote monitor **114** may then transmit the settings of the remote monitor to the secure store for storage and use when triggering alerts associated with the remote monitor.

At block **1640**, the remote monitor **114** monitors hosts' analyte levels as permitted. The monitoring can include monitoring a plurality of hosts using the remote monitor, as discussed in more detail with respect to FIG. **1**. The monitoring can include receiving notifications triggered by secure server **110** and sent via notification service **112** and viewing sensor data accessible from secure server. For example, in some implementations, a user can activate the remote monitoring application on remote monitor **114** to view a dashboard page of a plurality of host's glucose levels.

Example Invitation to Become Remote Monitor

As discussed above in block **1610** of FIG. **16**, a user can receive an invitation to remotely monitor host **199**. In some implementations, the invitation is the form of an email, such as that depicted in FIG. **12**. The user can accept or deny the invitation using the email. The user can accept the invitation by indicating that the user wants to install the remote monitoring application by selecting selectable text **504**, or deny the invitation by selecting selectable text **508**. If the user denies the invitation, then the remote monitoring system **100** can notify the host that sent the invitation of the denial by sending a notification via server **110** and/or notification service **112** to communication device **105**, for example. However, if the user accepts the invitation, then the remote monitoring system **100** can notify the host of the acceptance by sending a notification via server **110** and/or notification service **112** to communication device **105**, for example, and process **1600** continues to block **1620**.

In some implementations, a receipt accepting the invitation automatically sets up a remote monitoring account on server **110**. That is, the recipient need not log in and create an account, as the host provided account creation information (recipient name, email, phone number and the like) for the recipient when generating the invitation. Further, the host can include a picture of the host during the invitation creation process so that the invitation includes a picture of the host in the invitation sent to the recipient (which can help the recipient know the invitation is valid) and the picture of the host can be used as the picture of the host in the remote monitor (such as on a dashboard as discussed with reference to FIGS. **18**A and **18**B and elsewhere).

The invitation can include a single use token which the recipient of the invitation can use to accept the invitation without requiring the recipient to log into the remote monitoring system, in some implementations. The token can be in the form of a Globally Unique Identifier (GUID). The invitation may also include a timestamp of when the invitation was sent and when the invitations expires.

System Status View

In some implementations, a user of remote monitoring system **100** may not readily know if the remote monitoring system **100** is working or why the system may not be working. For example, in the implementation of FIG. **2**B, a host **199** may not realize that data is not being transmitted

from the sensor system **8** to the server **110**, or even if the host realizes that data is not being transmitted, the host my not recognize where the problem lies so that data transmission can resume. Accordingly, some embodiments provide a system status page to help a user identify if the system is working correctly, and, if not, what the source of the problem may be.

FIGS. **11**A and **11**B are exemplary views of a status page **1100** in accordance with some implementations. Status page **1100** includes a status bar **1110** that includes representations of various components of remote monitoring system **100**. In this example, components of the system **100** include a docking station **1114**, a host communication device **1118** and a server **1112**. Communication channels between each of the components between components of system **100** are also included in FIGS. **11**A and **11**B, such as a first communication channel **1116** (e.g. Bluetooth®) between the docking station **1114** and the host communication device **1118**, and a second communication channel **1120** (e.g. Wi-Fi or cellular) between the host communication device **1118** and the server **1122**. The status bar **1110** can indicate components and communication channels that are determined to be working and not working. For example, if a connection is determined to be working, then the connection can be graphically displayed in a first state, and if the connection is not working then the connection can be graphically displayed in a second, different state. The first state and the second state can be depicted differently, for example, using color (e.g., green if in the first state, red if in the second state), and/or graphics (e.g. a solid line if in the first state and a broken line if in the second state) and the like. Further, each portion of the status bar, **1114**, **1116**, **1118**, **1120** and **1122** can be user selectable, where if a user selects a particular portion, the host monitoring application can display help information (in the form of a pop-up message or new display screen, for example) that can help a user resolve issues associated with the portion selected by the user. For instance, if the docking station icon **1114** is in the second state and the user selects the docking station icon, the remote monitoring application can display a message prompting the user to make sure the docking station is plugged in to a power supply. Further, the remote monitoring application can display a message prompting the user to ensure the host monitoring device has Bluetooth connectivity enabled, for example, if the first communication channel is in the second state and the user selects the first communication channel.

Status page **1100** can also include a character icon **1132** that displays an overall status of the system. In the example of FIGS. **11**A and **11**B, the character icon **1132** is in the form of a monster holding a sign. The appearance of the character icon **1132** can change based on the status of the system so a user can quickly determine the status by viewing the character icon. For instance, character icon **1132** can have a smiling expression and holding a sign with a check mark to indicate the system is working and transmitting sensor data, as illustrated in FIG. **11**A. In contrast, the character icon **1132** can have a frowning expression and holding a sign with an X to indicate the system is not working, as illustrated in FIG. **11**B. The color of the character icon **1132** can also vary depending upon the status of the system, such as green when the system **100** determines the system is working (i.e. data is being sent from the host to the server **1110**) and red when the system determines the system is not working.

The eyes of the character icon **1132** can also help indicate to a user if the system is working, such as the eyes blinking if host monitoring application is working, or the eyes not blinking if the eyes are not blinking. The blinking of the eyes can also correspond to the transmission rate or each transmission between components of the systems, such as the docking station **103** and the host communication device (FIG. **2**C) or receiver **102** and gateway **104** (FIG. **2**A). In this manner, the host monitoring application can allow a user to determine if the remote monitoring system is actively working (i.e. eyes will be blinking), as opposed to the remote monitoring application being frozen in a state indicating the system is working even though it is not. It should be understood that eyes blinking is but one example implementation, and that other features indicating continued transmission between components of the system can be used in addition or instead to the eyes blinking, such as the character icon walking, jiggling, jumping or the like.

Host monitoring application can also display a status tab **1124** on status page **1100** and any other pages displayed by host monitoring application, as illustrated in FIGS. **11**A and **11**B. Status tab can be part of a menu that includes a plurality of different selectable tabs associated with different display pages of the host monitoring application that, when selected, display the associated display page The tabs in FIGS. **11**A and **11**B additionally include a follower tab, **1126**, account tab **1128** and more tab **1130**. Notably, the status tab can always display an indication of the connection state of the system, such being displayed in green and with a check mark, as illustrated in FIG. **11**A, if the system is working, or in red and with an X, as illustrated in FIG. **11**B, if the system is not working. The status tab can be displayed regardless of the current page being displayed, thereby providing the user with an indication of the status of the system regardless of the page being displayed.

In some implementations, host monitoring system **198** may be configured to periodically send messages to server **110**. If the server detects a lack of messages from the host monitoring system **198** for a predetermined amount of time, then the server can trigger a notification to be sent to the host monitoring system (such as receiver **102**, gateway **104** or host communication device **105**) notifying the host of the lack of messages so that the host can check to determine if the host monitoring system is working, using for example status page **1100**.

Host Monitoring Control Pages

Host monitoring application can also include various display pages that allow the user to view statuses of remote monitors **114** and configure permissions and settings associated with remote monitors.

FIG. **14** illustrates an overview page **1400** in accordance with some implementations. Overview page can include a plurality of cells **1402***a*-**1402***e*, each cell associated with a remote monitor or potential remote monitor. Each cell can include a name **1410***a*-**1410***e* associated with the remote monitor for identification purposes. The cells **1402***a*-**1402***e* can also be displayed according to a status of the remote monitor. For example, cell **1402***a* is grouped under a removed by remote monitor (referred to as a follower in FIG. **14**) status **1404***a*, cell **1402***b* is grouped under an expired invitation status **1404***b*, cell **1402***c* is grouped under an active status **1404***c*, cell **1402***d* is grouped under an invited status **1404***d*, and cell **1402***e* is grouped under a not sharing status **1404***e*. Note that a plurality of cells can be displayed under each group; FIG. **14** merely illustrates one cell per grouping for ease of explanation of the different groupings.

Page **1400** also includes a selectable help icon **1406***a*-**1406***e* associated with each group status. By selecting a help icon, the host monitoring application can provide further

information to a user that explains what the associated status involves. The help information can be displayed in a pop-up window for example.

Icons can also be displayed in a cell that illustrate permissions and/or enabled functions associated with that remote monitor. For instance, icons **1412** and **1414** indicate that remote monitor associated with cell **1402***c* has notifications enabled and has permission to view trend graph information associated with the host being monitored, respectively. In contrast, if a remote monitor does not have permission for a particular function, like viewing a trend graph of a host, then the corresponding icon can either not be displayed in the cell or a different icon indicating the lack of permission can be provided instead.

Selectable tabs can also be provided in each cell. For example, FIG. **14** illustrates removal tabs **1408***a* and **1408***b* that remove the cell from the page when selected by a user. Arrow tabs **1416***c*-**1416***e* can be used to provide further information about the remote monitor associated with that cell. For example, selecting a selectable arrow **1416** can cause the host monitoring application to transition to settings display page that provides more detail about the associated remote monitor and the remote monitor's settings.

An exemplary settings display page **1500** is illustrated in FIG. **15** in accordance with some implementations. Settings display page **1500** can include identification information, such as a name **1502** and email address **1504** associated with the remote monitor, permissions of the remote monitor and notification settings of the remote monitor. In the example of FIG. **15**, the permissions can include a trend graph permission **1504** tab that a user can use to toggle between allowing and denying permission to view the graph. If permitted, remote monitoring system **100** allows that remote monitor to view trend graph information of the host **199** and, if denied, then the remote monitor cannot view the trend graph information of the host. Notification settings allow the user of host monitoring application to view the current notification settings of the associated remote monitor. The notification settings can include an urgent low notification alert **1506**, a low notification alert **1508**, a high notification alert **1509** and a no data notification alert **1510**, and each alerts associated status (e.g., associated threshold values and whether the alert is off or on). In some implementations, a user using host monitoring application can modify the remote monitors' settings using page **1500**, for example, but in other implementations some or all of the settings can only be modified by the remote monitor, as indicated in FIG. **15**.

Display page **1500** can also allow a user of the host monitoring application to pause and cancel capabilities of remote monitor **114**A monitoring the host **199**. A pause/resume control button **1514** can selectably stop and re-start remote monitoring capabilities of the remote monitor, such as stopping and starting notifications being sent to the remote monitor and/or permission for the remote monitor to view sensor data of the host. Such a function can be useful in instances where a host does not always want a remote monitor to be monitoring the host. A specific example can include a baby sitter as a remote monitor. It may be desirable for the baby sitter to have remote monitoring capabilities when caring for a child being monitored by the host monitoring system, but stop the remote monitoring when the baby sitter is no longer caring for the child. This way, a new invitation need not be sent to the baby sitter each time the baby sitter cares for the child in order to selectively control monitoring by the baby sitter.

A Delete Remote Monitor control button **1516** can be used to delete the remote monitor from the list of remote monitors that can monitor the host. In contrast to the pause/resume control **1514**, deleting a remote monitor using the delete control **1516** would necessitate the host to re-invite the person to become a remote monitor in some implementations. As discussed elsewhere herein, remote monitoring system **100** may have a predefined limit to the number of remote monitors that can monitor a host, thus it may be become necessary for the host to delete the remote monitor so that the host can add another remote monitor in some implementations.

In some implementations, remote monitoring system **100** sends a notification message to a remote monitor that has had its permissions or settings changed, or has been paused, resumed or canceled by the associated host system. This way, the remote monitor notified of the change and is not relying on the previous configuration.

In addition, each of the pause, cancel, and resume functions may be configured globally across all remote monitors associated with the host instead of or in addition to individual monitors as described above. In the case of a global function, separate global pause, cancel and resume control buttons can be provided on page **1400** (not illustrated in FIG. **14**), for example, where pressing the global control button implements the respective function globally across all remote monitors monitoring the host.

Remote Monitoring Dashboard View

As discussed elsewhere herein, the remote monitor **114** can provide a so-called dashboard view of hosts it is monitoring implemented on remote monitoring device. FIGS. **18**A and **18**B are two different implementations of dashboard page **1800** in accordance with some implementations. The dashboard **1800** can include a plurality of cells **1802***a*-**1802***d*, each associated with a different host. Each cell **1802** can include identifiers of the host, such as a default name of the host and a picture of the host **1804***a*-**1804***d* provided in the invitation.

In the implementation of FIG. **18**A, each cell lists a current status of the cell, such as a time **1812***a* when the analyte value **1806***a* currently displayed in the cell was measured, a statement **1812***b* whether the host is using the remote monitoring system **100**, a statement **1812***c* whether the hosts host monitoring system is working, or a statement **1812***d* indicating that the remote monitor has been paused, for example.

In the implementation of FIG. **18**B, the cells **1802** can be grouped on page **1800** according to the status of the cell, such as removed **1814** by the host (referred to as Sharer in FIG. **18**B), active **1818** (i.e., system is connected and providing data of the associated host to the remote monitor), disconnected **1824** (i.e. system is not connected, e.g., because receiver **102** is not in docking station **103** in the implementation of FIG. **2**B) and not sharing **1826** (i.e. the host has paused the remote monitor). Further, cells within a group can be ordered by severity of the monitored condition or other criteria, as discussed elsewhere herein.

Cells **1802** can also include an indication of the permissions and/or settings of the remote monitor associated with that host. For example, a trend graph icon **1810** can indicate that the remote monitor has permission to view a trend graph of sensor data of that host.

Referring again to FIG. **18**B, cells **1802** that are in the active group **1818** can also include information about the health condition being monitored. For example the cell **1802** can display the most current analyte concentration value **1806***a* that was provided to remote monitor and an trend arrow **1808***a* indicating a rate of change of the measured analyte. Further information can also be provided in the cell,

such as a time **1812***a* associated with the measurement of the displayed analyte concentration or if data has not been received from the host monitoring system.

User selection of a cell **1802** can also cause the remote monitor display to transition to another display page that provides additional information about the host associated with that cell. For example, the remote monitor can transition to a trend graph display (FIG. **19**) associated with that host or a settings page (FIG. **17**) associated with that host (the arrow ">" can indicate if more information is available for the cell.

Voice Integration

In some implementations, users of the remote monitoring system **100** can interact with the system using voice-recognition. The interactions can include outputting a glucose value, inputting a calibration value, setting alarm criteria (e.g. changing an alarm profile, changing an alarm threshold, turning off or on a particular alarm, and acknowledging an alarm).

In some implementations, a person using remote monitor **114** can query the monitor using a voice recognition application running on the monitor for a host's glucose value. As a specific, non-limiting example, a user could query the voice recognition application for a particular host's glucose value by pressing a button on the monitor **114** and speaking: "Tell me Joe's current glucose level." In response, the monitor can open the remote monitoring application to find the host named Joe that the monitor is monitoring and Joe's current glucose level. The remote monitor **114** can then audibly output and/or display the glucose level, such as "Joe's glucose level is 125." In some implementations, the remote monitor **114** can also automatically bring up a particular view in response to the user querying for a glucose value, such as one of the views displayed in FIGS. **18**A, **18**B and **19**. If the view is associated with a particular individual, then the view can be of the individual about whom the user was querying, such as trend graph view of FIG. **19** associated with Joe in the above example.

Similarly, it should be understood that a host using a device of host monitoring system **198** can query the system for his or her own glucose level using one or more of the features described above, and that the above example is not limited to only remote monitoring device **114**.

Further, the remote monitoring system **100** (or one or more components thereof) can be configured to automatically provide voice feedback to a user. For example, receiver **102** or host monitor **114** can be user-configured to automatically provide an audible alert to a user indicating a monitored analyte value and/or rate of change. In some implementations, the voice feedback can be configured so a user can specify whether voice feedback is enabled and, if enabled, under what conditions voice feedback will be provided. The conditions can include one or more of a time interval (e.g., every 5 minutes), or if a specified analyte measurement threshold (e.g., analyte value or rate of change value) is crossed.

In some implementations, host monitoring system **198** can also enter a calibration value using voice recognition. Here, a user can direct the host monitoring system **198** to enter a calibration value by pressing a button on a device of the host monitoring system **198** (e.g. a button **124** on receiver **102**) and speak: "Enter calibration value of 108." The host monitoring system **198** can then use the calibration value to calibrate the host monitoring system **198** as it would had a user inputted the value by hand, for example.

Further, whether or not voice calibration is used to enter a calibration value, host monitoring system **198** (e.g., more specifically receiver **102**) can confirm to the user that the entered calibration value is trustworthy. For example, in a situation where an entered calibration value is much different from a currently monitored analyte value, the system may notify the user that the calibration value may be in error. This notification can be an audible, verbal notification, such as "Please check the calibration value again", and/or textual alert. In such a situation, the user may want to re-check the number inputted into the monitoring system to ensure the user correctly entered, and/or obtained the calibration value. The check can be based on the host monitoring system determining a difference between the calibration value and a currently measured value are within predetermined thresholds, where the difference can be an absolute difference or percentage difference.

Trend Graph View

FIG. **19** is an exemplary page that provides a trend graph **1914** of a host's monitored analyte concentration in accordance with some implementations. The trend graph can display a trend line **1916** of measured analyte concentrations, as well as low and high thresholds **1918** and **1920** that are used for alerting either the remote monitor **114** or the host monitoring system **198**. The trend graph page can also include a user-selectable slider bar that allows a user to select different time frames of sensor data to view, such as three, six, 12 and 24 hour views. A picture of the host **1904** and name of the host **1902** can also be provided so that a remote monitor is not confused as to the individual being monitored in case the remote monitor is monitoring a plurality of different hosts.

In some implementations, the page of FIG. **19** can automatically be displayed when the remote monitoring application is initially opened responsive to a user directly opening the application and/or a user opening a remote monitoring notification on remote monitor **114** sent by server **110** or notification service **112**, as discussed elsewhere wherein. To illustrate, when a notification is received by a remote monitor **114**, the remote monitor may display the notification on a lock or home screen. A user can select the notification (e.g. using a predefined gesture), the recognition of which by the remote monitoring device **114** causes the remote monitoring device to display the trend graph of the host associated with the notification.

In some implementations, trend graph **1914** can automatically modify the scale of the graph based on one or more criteria. The criteria can be a time of day (e.g. morning, lunch-time, bed-time, night), a current analyte value being monitored (e.g. a glucose concentration being monitored and displayed on trend graph **1914**), a current rate of change of a measured analyte concentration being monitored, whether a particular alarm and/or threshold has been triggered, such as a hypoglycemia-related or hyperglycemia-related alarm, and the like. One or both of the x-axis scale and y-axis scale of the trend graph **1914** can be recalled.

To illustrate, an exemplary implementation can be that the trend graph **1912** rescales when a low threshold is crossed—potentially indicating a hypoglycemia or near hypoglycemia condition in the host—the trend graph **1914** can reduce a default y-axis scale of 400, as illustrated in FIG. **19**, to 200. The time scale can also be reduced from a present time scale, such as reducing the time scale from a 24 hour view to a 3 hour, or even from a 3 hour view to a one hour view. Modifying the scale can provide better resolution to the viewer of trend graph **1914** of a problem zone. The graph can then automatically revert to the default scale (e.g. 400) upon the satisfying of a condition, such as once the user's

analyte concentration comes back above a threshold that triggered the scale modification, after a predetermined amount of time or the like.

Further, so that a user understands that the scale has been modified, the display can also provide an indication that the scale has been modified. For instance, in the example above, the indication can include one of more of the screen flashing, changing color and providing a textual reason for the rescaling (e.g., "hypoglycemia threshold exceeded").

It should be understood that while the above-described features of trend graph **1914** can be used on any computing device described herein, including a host's monitoring device and a remote monitor's monitoring device. Nothing herein should be construed as limiting the application of these features to a particular device or application.

Remote Monitor Settings Page

FIG. **17** is an implementation of a settings page **1700** displayed on remote monitoring device **114** that can allow the remote monitor to configure remote monitoring settings of a host. Settings page can include a picture field that displays a picture of the host **1506** and a name field that displays a name of the host, both of which can be modified by the remote monitor using the settings page **1700**. In some implementations, the picture and/or name are at least initially provided by a host during the invitation process described above, but the remote monitoring system allows a user of the remote monitor to later modify the picture and/or name. The settings page also includes settings for various alert/notification settings, such as an urgent low alert **1706**, low alert **1714**, high alert **1724** and not data alert **1736**. The function of each of these alerts is discussed elsewhere herein. As illustrated in FIG. **17**, the settings associated with each of these alerts can be modified, such as turning the alert on or off, changing the threshold value(s) associated with each alert and changing an alert alarm (e.g. sound, volume, vibration, or tones) associated with each alert.

Automatic Detection of New Receivers and Registration

In some implementations, receivers **102** need to be associated with a host **199** so that when glucose data is received by server **110**, the data can be associated with the host. Accordingly, remote monitoring system **100** can assign a receiver to a host. This can initially be done through the pairing process discussed above with respect to block **1016** of FIG. **10**. If a host receives a new receiver, to make a friendly user experience and prevent errors, the host monitoring application can see that a different serial number is being used, check with the server **110** to see if this is a new receiver or if this receiver is already owned by another host and asks the host via communication device **105** if this is their receiver and allows them to take ownership or it gives them an error telling them that it is already owned.

Accordingly, an exemplary detection of a new receiver process can be as follows. First, the host communication device **105** if a new receiver is being used by validating with server if the receiver is owned by someone else (via comparison of receiver serial numbers to a database, for example). If the server determines that no one else owns the receiver, then the host monitoring application asks if the user if he or she wants to make that receiver theirs. If yes, then the receiver and the data from that receiver are associated with that host.

Connection Processing

FIG. **20** is a diagram illustrating an exemplary sequence of initial processing **2000** that can take place using remote monitoring system **100**. FIG. **20** is described with respect to the system architecture of FIG. **2**A, although it should be process **2000** can be modified to be used with other system architectures, including that of FIG. **2**B or **2**C, as would be apparent to one of ordinary skill in the art.

At **2002**, receiver **102** sends a heartbeat message to gateway **104** to trigger first connection logic. In some implementations, connection logic can include triggering an application resident on a gateway **104** to begin connection establishment. The application may have been shut down or in a sleep or background mode of operation, and the connection logic allows the application to initiate a connection. As an example, connection logic can initiate radio connection procedures for an application running in the background of a mobile device running Apple's iOS operating system.

Gateway **104** then requests **2004** and reads **2004** manufacturing data from receiver **102**, and subsequently checks with server **110** regarding the assignment status of the receiver **102** based on the data read at **2004**. In some implementations, the manufacturing data is a unique identifier associated with the receiver **102**, such as the receiver's serial number.

Assuming the assignment status is valid at **2008**, gateway **104** requests and reads the latest analyte concentration value at **200** from receiver **102** at **2012** and **2014**, respectively. The gateway **104** also requests and reads the receiver system time at **2016** and **2018**, respectively, and requests and reads system UTC time from server **110** at **2020** and **2022**, respectively. Any offset (e.g. due to system drift) between the receiver time and the UTC time can be stored in RAM of the gateway **104** to offset analyte concentration timestamps when uploading data to server **110**.

Gateway **104** then notifies server **110** of a remote monitoring session starting at **2024**, and requests and syncs past data with the server **110** to ensure no gaps in data. To this end, gateway **104** reads a predetermined number of past analyte concentration values (e.g. past **288** values) stored at the receiver **102** at **2026** and **2028**. The past analyte concentration value data are stored at gateway **104** but not yet uploaded to server **110**. Instead, gateway **104** requests that latest analyte concentration value data from server **110** at **2030** and **2032**. At **2034**, gateway **104** uploads to server **110** only analyte concentration value data not yet uploaded to the server **110** based on the latest analyte concentration value data read at **2030** and **2032**. Gateway **104** then marks all analyte concentration data stored locally as uploaded to the server.

FIG. **21** is an exemplary diagram of steady state processing **2100** of remote monitoring system **100**. Steady state processing **2100** can follow initial processing **2000** described with respect to FIG. **20**. Also, like FIG. **20**, FIG. **21** is described with respect to the system architecture of FIG. **2**A, although it should be process **2000** can be modified to be used with other system architectures, including that of FIG. **2**B or **2**C, as would be apparent to one of ordinary skill in the art.

During steady state processing **2100**, each time a heartbeat message **2102** is transmitted by receiver **102** and received by gateway **104**, the gateway checks to see if it is time to request data from the receiver **102**. The gateway **104** uses the receiver **102** system time and the system time of the last analyte concentration to determine if it has been more than a pre-set amount of time, which may correspond to an analyte concentration collection time interval of host monitoring system **198** (e.g., 5 minutes) or other time (e.g., once every 4 seconds or once every minute). If past the pre-set time, gateway **104** performs processing to obtain getting the next analyte concentration value data from the receiver **102** as follows.

The gateway **104** requests the latest analyte glucose value data and the current system time from the receiver **102** at **2104** and **2106**. If the analyte concentration value data is valid at decision block **2108**, the analyte concentration value data is saved locally at gateway **104**. Then, the analyte concentration value data is uploaded to the server **110** at **2110** and a heartbeat counter is reset at **2112**.

However, if the analyte concentration value data is not valid, the analyte concentration value data is not saved locally and the heartbeat counter is reset. A CheckSession call **2114** is made to the server **110** to keep the current log in session active. The CheckSession call is made to avoid login authentication for temporary outages of data from the receiver **102**.

Loss of Data Alert

In some example implementations, the secure server **110** may include a rule to automatically trigger a notification message or another communication mechanism (e.g., a phone call, short message service message, and the like) to a remote monitor **114** if data has not been received from host monitoring system **198** associated with the remote monitor for a predetermined amount of time. This way, a user of remote monitor **114** can be aware that something may be wrong with host monitoring system **198** and attempt to contact the host.

Location-Based Alerts

In some example implementations, the secure server **110** may use the location of the receiver **102**, gateway **104**, host **199**, and/or remote monitor(s) **114** when determining whether to send a notification message and/or determine destination of a notification message. For example, when a host being monitored is in a first location and travels to a second location, the secure server **110** may, based on rules, select a first remote monitor **114**A near the first location and, when the host moves to the second location, select a second remote monitor **114**B located near that second location. Location may also be used to vary alerts and notifications. For example, the secure server **110** may vary the rules used to trigger an alert or notification based on the host's location. Location may be used in combination with time as well, so the secure server **110** may vary thresholds associated with alerts and notifications based on location and/or time of day.

Acknowledgement Notifications

In some example implementations, the receiver **102** or gateway **104** may present a prompt (e.g., message, window, etc.) at a user interface requiring a host to acknowledge the triggered alert and/or indicate what corrective action was taken in response to the alert. The prompt may include a prepopulated list of options that the user can select (e.g., administered insulin, consumed carbohydrates, and the like) to indicate the corrective action that was taken. A notification message may be sent directly to one or more remote monitors **114**, or through the secure server **110** and/or notification service **112**, to the remote monitor(s), so that the remote monitors are aware that the patient has acknowledged the alert and/or that corrective action taken (and/or a description of the corrective action).

In addition, remote monitor **114** can allow a user to select from a plurality of pre-populated messages to send to host monitoring system. A user can select the notification, whereupon the remote monitor displays a list of pre-populated text messages that the user can select from to send to the host monitoring system. The messages can be selected by remote monitor to be relevant to the underlying cause that triggered the notification message. For instance, if the notification message was triggered by a low glucose level of the host, then the messages can be statements related to low glucose levels, such as "are you feeling okay?", "should you drink some orange juice?", and the like. Each message can be user selectable, and when selected, cause the remote monitor **114** to send the message to the host monitoring system for display on the host monitoring system, either directly from remote monitor to host system **198** or indirectly through the server **110**, for example. In addition, selection of the notification can automatically display a prompt to call the host, where user selection of the prompt causes the remote monitor **114** to dial the phone number associated with the host (e.g. a smartphone that is part of the host monitoring system **198**).

Motivational Messages

In some example implementations, the alerts sent to the receiver **102** and/or the notification messages may include motivational concepts. For example, if the host-patient has minimized the rate of change in glycemic levels, the secure server may send an alert to the receiver **102** and/or a notification message to remote monitor **114** stating "Great job maintaining your therapy-keep it up!." These motivational concepts may positively motivate the users to stay on the therapy program. In some example implementations, secure server **110** may include one or more events mapped to motivational concepts, so that triggering an event causes sending a message including the motivation concept to the receiver **102** and/or a remote monitor **114**.

In some example implementations, the secure server **110** may use patterns, as noted above, to predict aspects of the patient-host's treatment. For example, a pattern may detect a glycemic change at a given time of day from a prior, established pattern, and then trigger a rule to send an alert to the receiver **102** and a notification to the receiver **114** stating, "Did you miss lunch?" These simple, non-technical query messages may evoke a better response from the host-patient to maintain a therapy, when compared to only providing measured data or statistics to a host-patient or remote monitor. In some example implementations, secure server **110** may include one or more events mapped to simple messages, so that triggering an event causes sending a message including the simple message to the receiver **102** and/or a remote monitor **114**.

Audit Trail

The secure server **110** may also provide an audit trail. For example, the secure server **110** may store information related to when notifications were pushed to the remote monitor **114** using, for example, notification service **112**, and when the remote monitor acknowledges the notification. The secure server **110** may also generate one or more reports to determine timelines and/or identify the effectiveness of remote monitors **114** (which can be used to select remote monitors and/or settings of system **100**, such as alert settings, to more effectively monitor host **199**).

Timestamping

In some implementations, analyte levels provided to remote monitors **114** may not be real-time. For example, while it may be desired to provide analyte values to remote monitors in real time, there may be a time delay between when the analyte value is measured by the analyte sensor system **8** and when the analyte level is provided to the remote monitor **114** and/or secure server **110**. The delay may be due to any of the sensor system **8** only transmitting values periodically to the receiver **102**, the receiver **102** transmitting only periodically values to gateway **104**, the gateway having difficulty connecting to secure server **110**, and secure server having difficulty connecting to remote monitor **114**, for example. Consequently, in some implementations, a glucose value transmitted to the remote monitor **114** is

displayed on the remote monitor with a time indicating the time to which the analyte value that triggered the notification corresponds (e.g., the analyte value that met or exceeded the threshold that triggered the notification). The time may be the time of day the analyte value was measured (e.g., 2:10 p.m. Pacific Standard Time), or may be a difference in time since the analyte value was measured (e.g., 2 minutes ago, 30 minutes ago, 4 hours ago, etc.).

In addition, due to a time delay, the secure server **110** may end up sending a notification to remote monitor **114** based on a time delayed analyte value. In such a case, the notification can include a time associated with the alert that triggered the notification, such as "Mike's blood glucose went below 70 mg/dl at 2:10 P.S.T." or "Mike's blood glucose went below 70 mg/dl 25 minutes ago." Further, because a notification may not be viewed right away on the remote monitoring device, the remote monitoring device **114** can automatically update any time associated with the notification until the notification is acknowledged.

To accommodate for differences in time zones between a host and a remote monitor, the remote monitoring system can use a universal time and then convert the universal time to the time zone of the remote monitor, in accordance with some implementations. That is, a time stamp of a sensor data value generated by host monitoring system **198** and provided to secure server **110** can be in Universal Standard time (UST) or Greenwich Mean Time (GMT) and provided to the remote monitor **114** in the same universal time, whereby the remote monitor converts the universal time to the time zone in which the remote monitor is located as indicated by the remote monitoring device.

In some implementations, due to difficulties with displaying time due to time lag and potential time zone differences between a host monitoring system **198** and remote monitor **114**, which can cause confusion, notifications sent to remote monitor **114** do not display a time. To remedy the lack of time indication, some implementations automatically open the remote monitoring application on the remote monitor **114** and display the user's monitored health information upon user acknowledgment of the notification. The host's monitored health information that is initially displayed upon opening the application can include indications of the host's current state, such as the most current analyte value and/or a trend graph showing the past three hours of the host's measured analyte level, such as the trend graph page illustrated in FIG. **19**.

Loss of Data Transmission

In some implementations, data may not be transmitted at times from the sensor system **8** to the secure server **110**. Depending upon the system, this may be due to an unintentional lost data transmission connection between one or more of sensor system **8** and receiver **102**, receiver **102** and gateway **104**, docking station **103** and host communication device **105**, or gateway **104** and secure server **110**, for example. Or, the loss may be intentional, such as a user turning one or more of the components of the remote monitoring system **100** off, such as the receiver **102** or host communication device **105**. In any such instance, the secure server **110** can be configured to automatically send a notification indicating the loss of data transmission to one or more of the host monitoring system **198** and remote monitors **114**A-**114**M upon detection of such a loss.

However, it may be desirable at times not to send such a loss of data transmission notification so remote monitors **114** are not overly messaged. As an example, a host being monitored may be sleeping at night and get up to go to the kitchen for a drink of water. This can result in a loss of data transmission if the sensor system **8** is out of range from the receiver **102** resting on a nightstand of the host **199**, for example. Consequently, a delay associated with loss of data transmission errors can be implemented so that the server **110** initiates a loss of data notification only if data is not received after a predetermined amount of time or after a predetermined number of attempted connection attempts with host monitoring system **198**.

Further, it may be desirable to not send loss of data notifications every time there is a loss of data transmission, even if the loss of data transmission is for an extended period of time. For example, in the implementation of FIG. **2**C, the docking station **103** may be stationary. Thus, a host may only be able to transmit health readings when the host has the receiver **102** docked in the docking station and the host is in sufficient proximity to the receiver and docking station for data transmission. However, a host may want to remove his or her receiver **102** from the docking station **103** when the host leaves for work, for example. It may not be desirable to trigger a notification to remote monitors **114** when the host removes the receiver from the docking station **103**, as this may not be considered an important enough event.

Accordingly, in some implementations, the remote monitoring system **100** can determine that the receiver was removed from the docking station **103** as opposed to, for some reason, the host monitoring system **198** not functioning correctly and not providing sensor data to the secure server. In one implementation, the remote monitoring system **100** determines that the receiver is not docked in the docking station **103** by monitoring transmissions from the docking station. For instance, transmissions from the docking station **103** that include information generated by the receiver **102** indicates that the receiver is docked and transmissions from the docking station **103** that do not include information generated by the receiver indicates that the receiver has been removed from the docking station.

Eyewear Display Device

Although the above disclosure is primarily described with respect to use of a hand-held computing device, it should be understood that other devices can be used instead or in place of the smart phone. For example, in some implementations, sensor data are transmitted from the personal computing device to a computing device in the form of eyewear and messages and information displayed on the eyewear for the user to view. An example of such eyewear is Google Glasses manufactured by Google, Inc. The user's eyewear interface can use a near-field radio link to receive data, either directly from sensor system **8**, or through an intermediary device, such as receiver **102** or gateway **104**.

In some implementations, transmission of the data may be event-driven, for example, driven by the occurrence of a low or high glucose excursion, as discussed herein.

Various implementations of the subject matter described herein may be realized in digital electronic circuitry, integrated circuitry, specially designed ASICs (application specific integrated circuits), computer hardware, firmware, software, and/or combinations thereof. The circuitry may be affixed to a printed circuit board (PCB), or the like, and may take a variety of forms, as noted. These various implementations may include implementation in one or more computer programs that are executable and/or interpretable on a programmable system including at least one programmable processor, which may be special or general purpose, coupled to receive data and instructions from, and to transmit data and instructions to, a storage system, at least one input device, and at least one output device.

These computer programs (also known as programs, software, software applications, or code) include machine instructions for a programmable processor, and may be implemented in a high-level procedural and/or object-oriented programming language, and/or in assembly/machine language. As used herein, the term "machine-readable medium" refers to any non-transitory computer program product, apparatus and/or device (e.g., magnetic discs, optical disks, memory, Programmable Logic Devices (PLDs)) used to provide machine instructions and/or data to a programmable processor, including a machine-readable medium that receives machine instructions.

To provide for interaction with a user, the subject matter described herein may be implemented on a computer having a display device (e.g., a CRT (cathode ray tube) or LCD (liquid crystal display) monitor) for displaying information to the user and a keyboard and a pointing device (e.g., a mouse or a trackball) by which the user may provide input to the computer. Other kinds of devices may be used to provide for interaction with a user as well; for example, feedback provided to the user may be any form of sensory feedback (e.g., visual feedback, auditory feedback, or tactile feedback); and input from the user may be received in any form, including acoustic, speech, or tactile input.

The subject matter described herein may be implemented in a computing system that includes a back-end component (e.g., as a data server), or that includes a middleware component (e.g., an application server), or that includes a front-end component (e.g., a client computer having a graphical user interface or a Web browser through which a user may interact with an implementation of the subject matter described herein), or any combination of such back-end, middleware, or front-end components. The components of the system may be interconnected by any form or medium of digital data communication (e.g., a communication network). Examples of communication networks include a local area network ("LAN"), a wide area network ("WAN"), the public land mobile network, satellite networks, and the Internet.

Although a few variations have been described in detail above, other modifications are possible. For example, while the descriptions of specific implementations of the current subject matter discuss analytic applications, the current subject matter is applicable to other types of software and data services access as well. Moreover, although the above description refers to specific products, other products may be used as well. In addition, the logic flows depicted in the accompanying figures and described herein do not require the particular order shown, or sequential order, to achieve desirable results. Moreover, as used herein the term "set" includes zero or more items, and the phrase "based on" can be used interchangeably (unless otherwise noted) with the phrase "based on at least." Other implementations may be within the scope of the following claims.

While the disclosure has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The disclosure is not limited to the disclosed embodiments. Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed disclosure, from a study of the drawings, the disclosure and the appended claims.

All references cited herein are incorporated herein by reference in their entirety. To the extent publications and patents or patent applications incorporated by reference contradict the disclosure contained in the specification, the specification is intended to supersede and/or take precedence over any such contradictory material.

Unless otherwise defined, all terms (including technical and scientific terms) are to be given their ordinary and customary meaning to a person of ordinary skill in the art, and are not to be limited to a special or customized meaning unless expressly so defined herein. It should be noted that the use of particular terminology when describing certain features or aspects of the disclosure should not be taken to imply that the terminology is being re-defined herein to be restricted to include any specific characteristics of the features or aspects of the disclosure with which that terminology is associated. Terms and phrases used in this application, and variations thereof, especially in the appended claims, unless otherwise expressly stated, should be construed as open ended as opposed to limiting. As examples of the foregoing, the term 'including' should be read to mean 'including, without limitation,' 'including but not limited to,' or the like; the term 'comprising' as used herein is synonymous with 'including,' 'containing,' or 'characterized by,' and is inclusive or open-ended and does not exclude additional, unrecited elements or method steps; the term 'having' should be interpreted as 'having at least;' the term 'includes' should be interpreted as 'includes but is not limited to;' the term 'example' is used to provide exemplary instances of the item in discussion, not an exhaustive or limiting list thereof; adjectives such as 'known', 'normal', 'standard', and terms of similar meaning should not be construed as limiting the item described to a given time period or to an item available as of a given time, but instead should be read to encompass known, normal, or standard technologies that may be available or known now or at any time in the future; and use of terms like 'preferably,' 'preferred,' 'desired,' or 'desirable,' and words of similar meaning should not be understood as implying that certain features are critical, essential, or even important to the structure or function of the invention, but instead as merely intended to highlight alternative or additional features that may or may not be utilized in a particular embodiment of the invention. Likewise, a group of items linked with the conjunction 'and' should not be read as requiring that each and every one of those items be present in the grouping, but rather should be read as 'and/or' unless expressly stated otherwise. Similarly, a group of items linked with the conjunction 'or' should not be read as requiring mutual exclusivity among that group, but rather should be read as 'and/or' unless expressly stated otherwise.

Where a range of values is provided, it is understood that the upper and lower limit, and each intervening value between the upper and lower limit of the range is encompassed within the embodiments.

With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity. The indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the

claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

All numbers expressing quantities of ingredients, reaction conditions, and so forth used in the specification are to be understood as being modified in all instances by the term 'about.' Accordingly, unless indicated to the contrary, the numerical parameters set forth herein are approximations that may vary depending upon the desired properties sought to be obtained. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of any claims in any application claiming priority to the present application, each numerical parameter should be construed in light of the number of significant digits and ordinary rounding approaches.

Furthermore, although the foregoing has been described in some detail by way of illustrations and examples for purposes of clarity and understanding, it is apparent to those skilled in the art that certain changes and modifications may be practiced. Therefore, the description and examples should not be construed as limiting the scope of the invention to the specific embodiments and examples described herein, but rather to also cover all modification and alternatives coming with the true scope and spirit of the invention.

What is claimed is:

1. A method for remotely monitoring glucose levels of one or more hosts who are remote to a remote monitoring apparatus and who are not in a medical facility, comprising:

executing a software application on a remote monitoring apparatus including a smartphone in communication with a remote server, the remote server configured to store glucose data associated with a plurality of hosts each measured by a continuous glucose monitoring system, wherein the software application is configured to be used by the remote monitoring apparatus to receive and present notifications and data pertaining to a health condition based on a glucose concentration state of one or more hosts established to be remotely monitored by a remote monitoring user using the remote monitoring apparatus, wherein the notifications are based on a specific rule set determined by the remote monitoring user for each host of the one or more hosts that the remote monitoring user is remotely monitoring;

receiving an input using the software application on the smartphone, the input comprising an indication of one of the one or more hosts that the remote monitoring user is remotely monitoring;

determining, using the software application on the smartphone, a selected host from the one or more hosts based on the indication;

requesting, using the software application on the smartphone, the glucose data associated with the selected host from the remote server; and

audibly providing and/or visually displaying, using the software application on the smartphone, a state of the selected host on a user interface of the software application based on the requested glucose data,

wherein the glucose data comprises glucose concentration values of the selected host measured using the selected host's continuous glucose monitoring system, and

wherein the specific rule set for each host of the one or more hosts that the remote monitoring user is remotely monitoring is established upon acceptance or modification of a corresponding set of recommended rule settings configured by each respective host of the one or more hosts.

2. The method of claim **1**, wherein the audibly providing the state comprises audibly outputting a particular glucose value.

3. The method of claim **2**, wherein the particular glucose value is the current glucose value.

4. The method of claim **2**, wherein the input further comprises an indication of a past time frame and the particular glucose value is a glucose value corresponding to the past time frame.

5. The method of claim **2**, wherein the audibly providing the state comprises audibly providing the particular glucose value using the smartphone and displaying the current glucose value on a display of the smartphone.

6. The method of claim **5**, the displaying the state comprises triggering display of a glucose trend graph of the selected host's measured glucose concentration over time.

7. The method of claim **1**, further comprising modifying the at least one rule of the specific rule set including modifying one or more of an alarm profile, changing an alarm threshold, or turning off or on a particular alarm.

8. The method of claim **1**, wherein the input further comprises an acknowledgement of an alert previously received by the smartphone, the method further comprising silencing the received alert.

9. The method of claim **1**, wherein the state of the selected host comprises one or more of a current glucose value of the selected host, a rate of change of glucose concentration of the selected host, or a location of the selected host.

10. The method of claim **1**, wherein the state of the selected host is displayed, and wherein displaying the state of the selected host includes displaying, on a display screen of the smartphone, a current numerical glucose value of the selected host and a trend graph of the host's glucose concentration over a time period.

11. The method of claim **1**, further comprising receiving an alert notification that an alert setting associated with a host of the one or more hosts has been exceeded, wherein the alert notification does not include glucose concentration values of the host to prevent instances where a glucose concentration value in the received alert notification would not be current.

12. The method of claim **11**, further comprising receiving a second input comprising an acknowledgement of the alert notification, and audibly providing and/or displaying the glucose concentration value of the host corresponding to the exceeded alert setting.

13. The method of claim **1**, further comprising receiving an alert notification that an alert setting associated with a host of the one or more hosts has been exceeded, wherein the alert notification includes a glucose concentration value of the host corresponding to the exceeded alert setting for a predetermined amount of time after the receiving the alert notification, after which the glucose concentration value is no longer included in the alert notification to prevent instances where the glucose concentration value in the received alert notification would not be current.

14. The method of claim **1**, wherein the received input includes a voice input from the user.

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