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Arkoff et al.

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(45) **Date of Patent: Dec. 20, 2022**

(54) **COMPREHENSIVE HEALTHCARE DATA MANAGEMENT SYSTEM**

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(73) Assignee: **OSSI**, Sudbury, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 199 days.

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(22) Filed: **Mar. 7, 2020**

(65) **Prior Publication Data**

US 2021/0050104 A1 Feb. 18, 2021

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/651,058, filed on Oct. 12, 2012, now abandoned.

(51) **Int. Cl.**

G16H 40/67	(2018.01)
G06Q 10/06	(2012.01)
G06Q 10/10	(2012.01)
G16H 40/20	(2018.01)

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

CPC ***G16H 40/67*** (2018.01); ***G06Q 10/06*** (2013.01); ***G06Q 10/1095*** (2013.01); ***G16H 40/20*** (2018.01)

(58) **Field of Classification Search**

CPC G16H 40/67; G16H 40/20; G06Q 10/06; G06Q 10/1095

USPC 705/2–3

See application file for complete search history.

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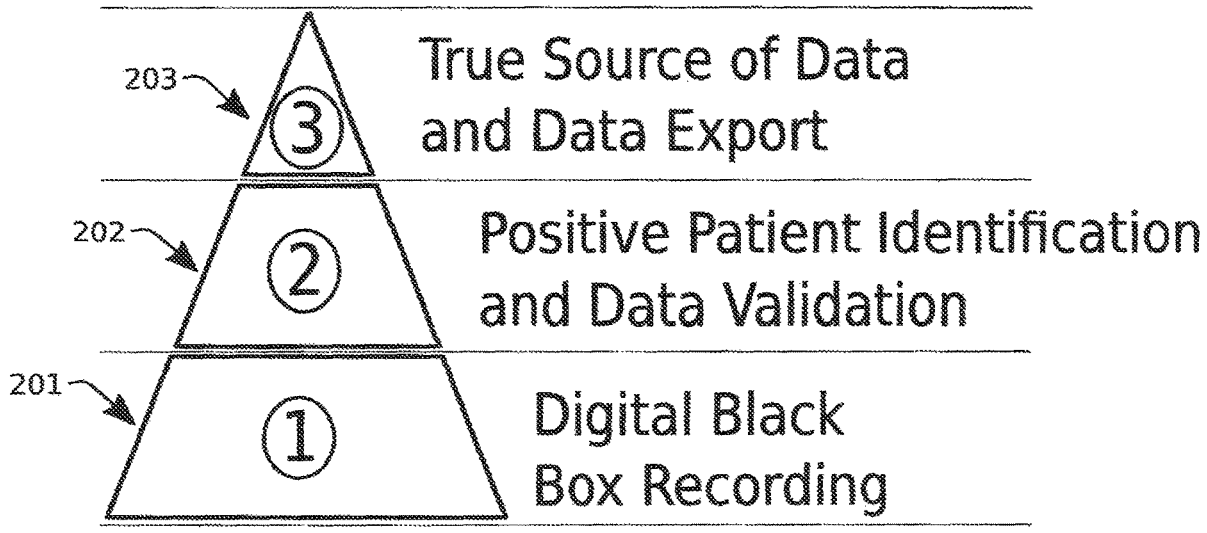
Primary Examiner — Michael Tomaszewski

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(57) **ABSTRACT**

A comprehensive health care data management system is provided. In an embodiment, a Medical Data Governance System records, secures, and provides appropriate access to all patient data. By concentrating all available relevant medical data into a single source, and providing a subset of data to each receiving subsystem with the correct source and time reference, the Medical Data Governance System becomes the True Source of Data and guarantees the data consistency through the use of block chain signatures. In another aspect of the invention, a system of servers is provided, which communicate data in real time with white boards stationed in the operating rooms of a healthcare facility. Medical personnel and healthcare facility staff members can view the formatted data on a white board and input new or revised data directly on the white board or at an input station near the white board.

14 Claims, 24 Drawing Sheets



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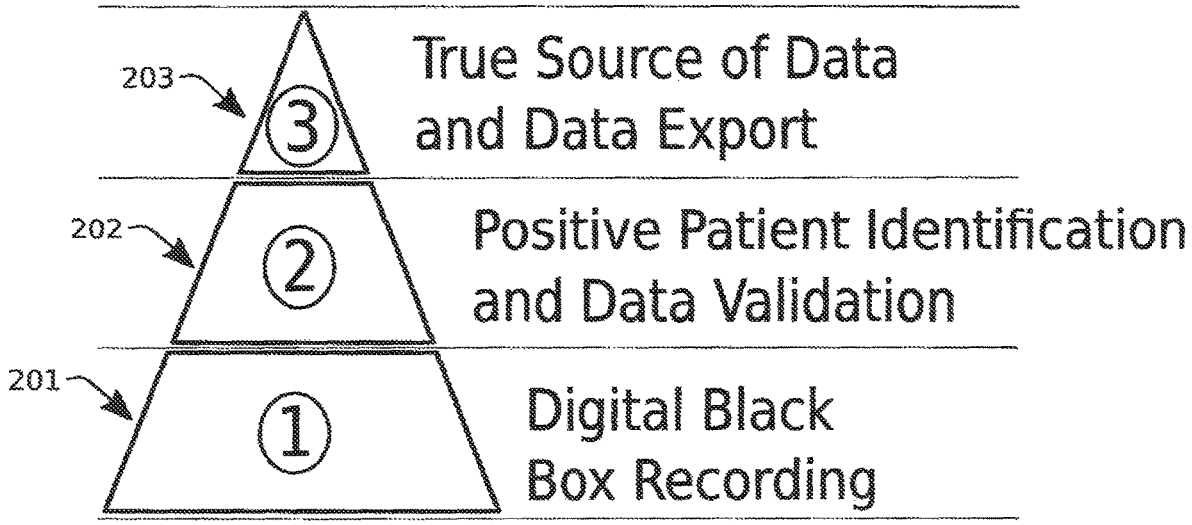

203
3
True Source of Data
and Data Export
202
2
Positive Patient Identification
and Data Validation
201
1
Digital Black
Box Recording

Fig. 1

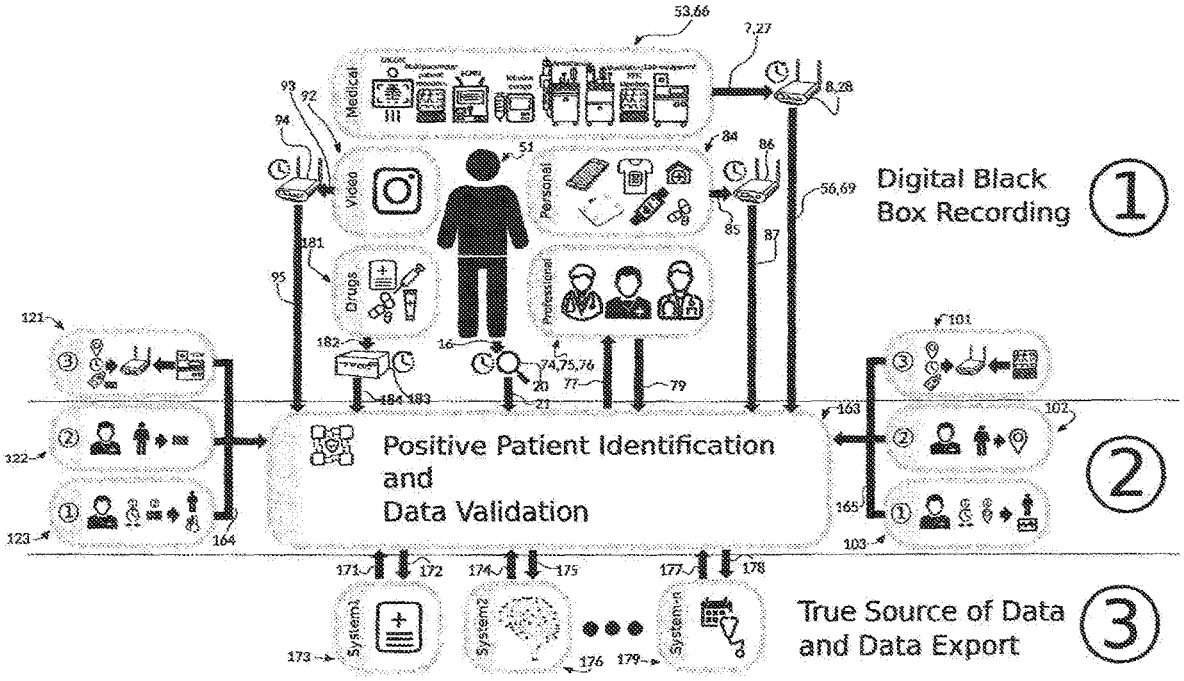

Medical
Video
Personal
Drugs
Professional
Digital Black Box Recording
1
Positive Patient Identification and Data Validation
2
True Source of Data and Data Export
3
System1
System2
System n

Fig. 2

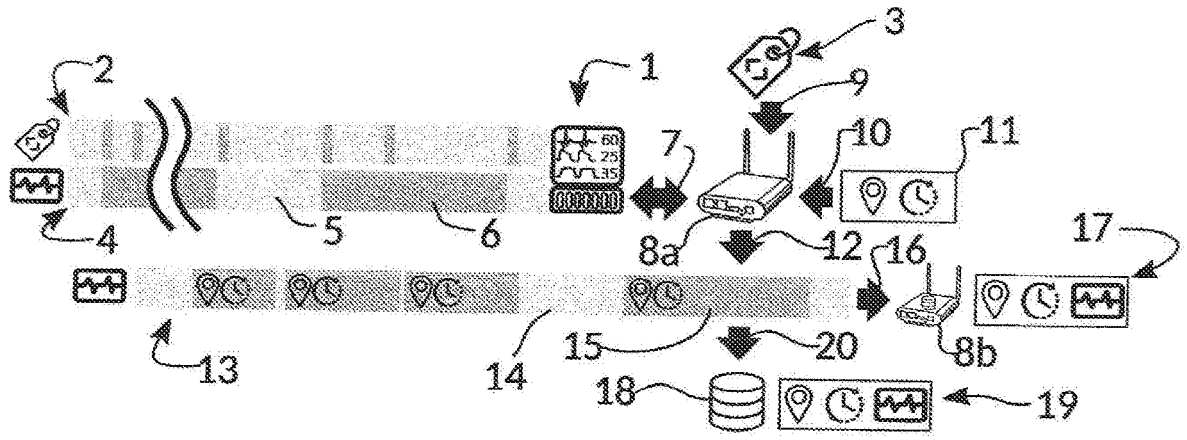


Fig. 3

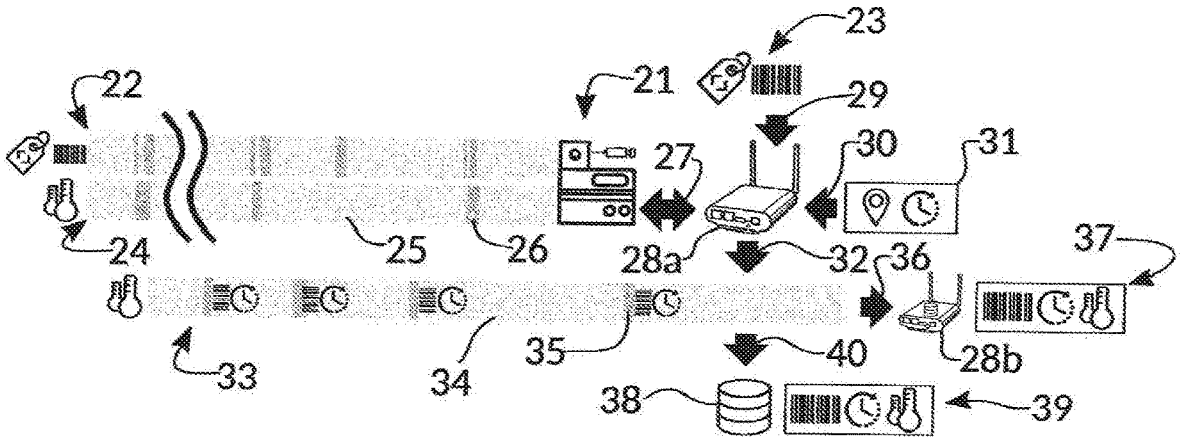


Fig. 4

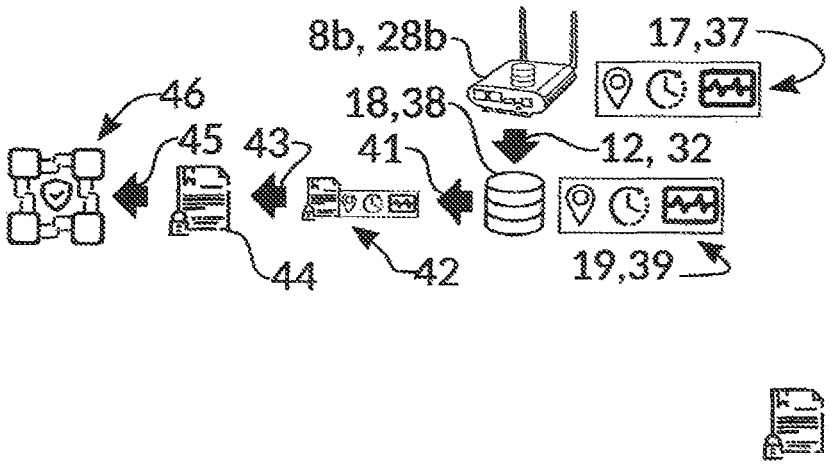


Fig. 5

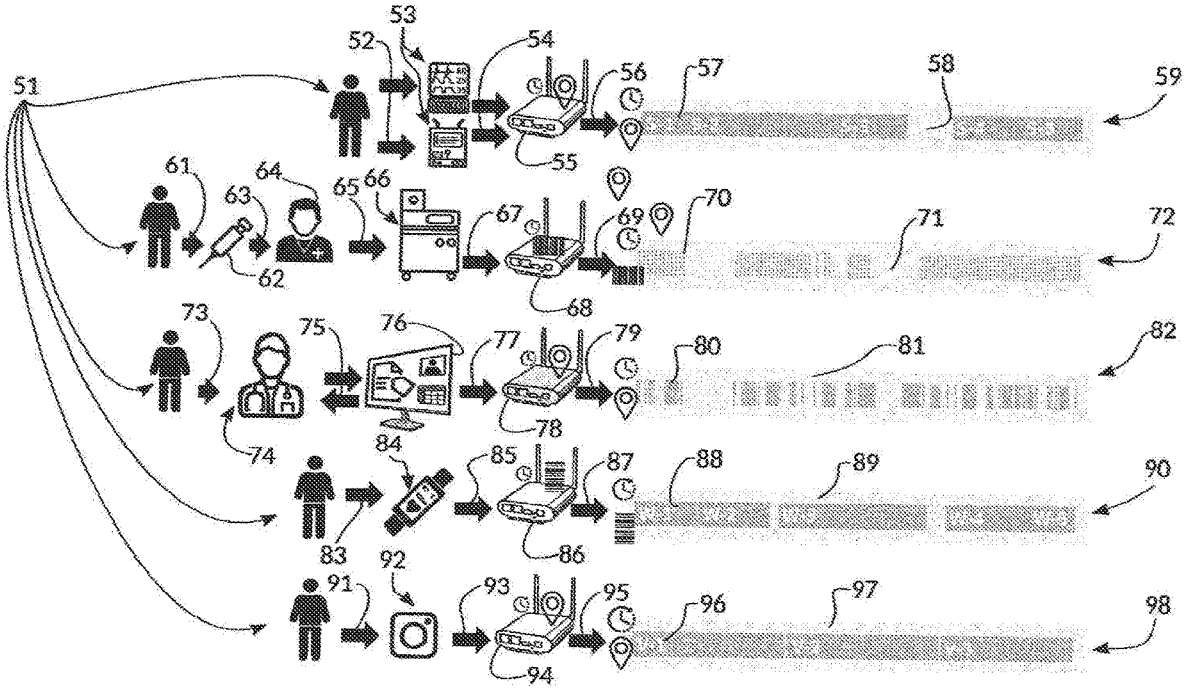

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Fig. 6

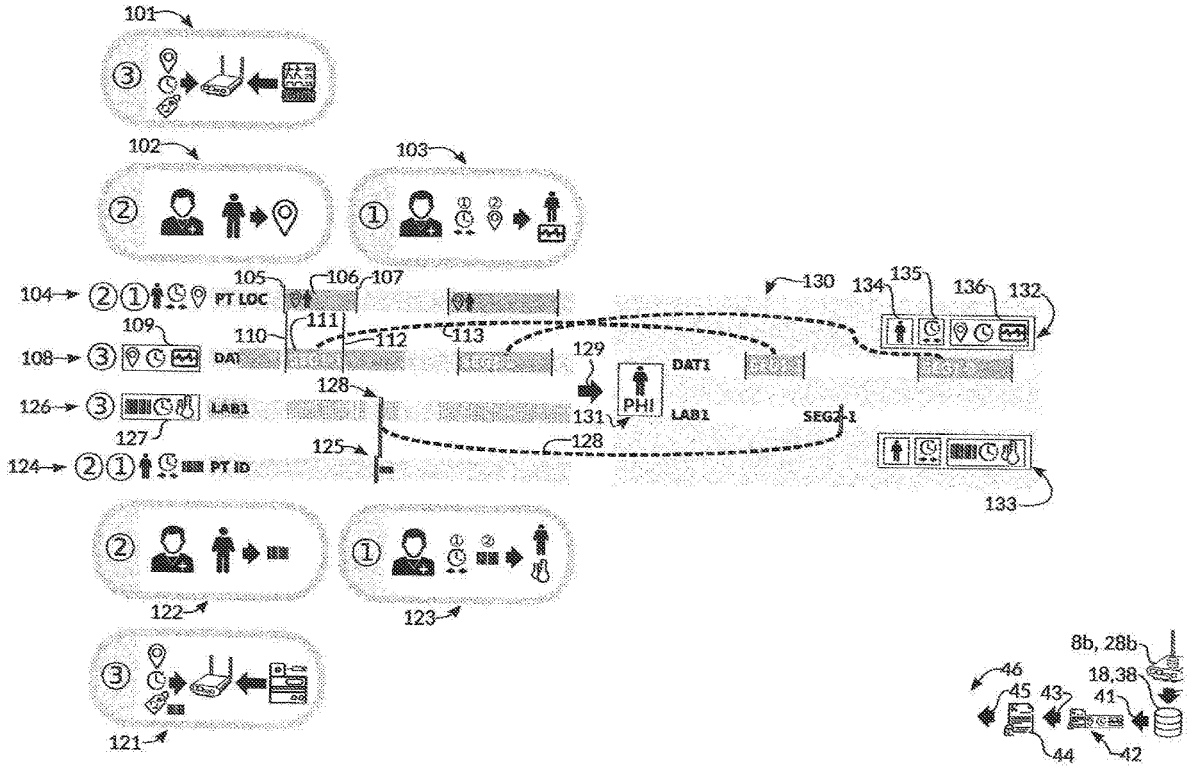

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PT LOC
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DAT
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113
126
LAB1
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124
PT ID
128
125
129
PHI
DAT1
131
LAB1
SEG1-1
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134
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133
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121
8b, 28b
18,38
46
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Fig. 7

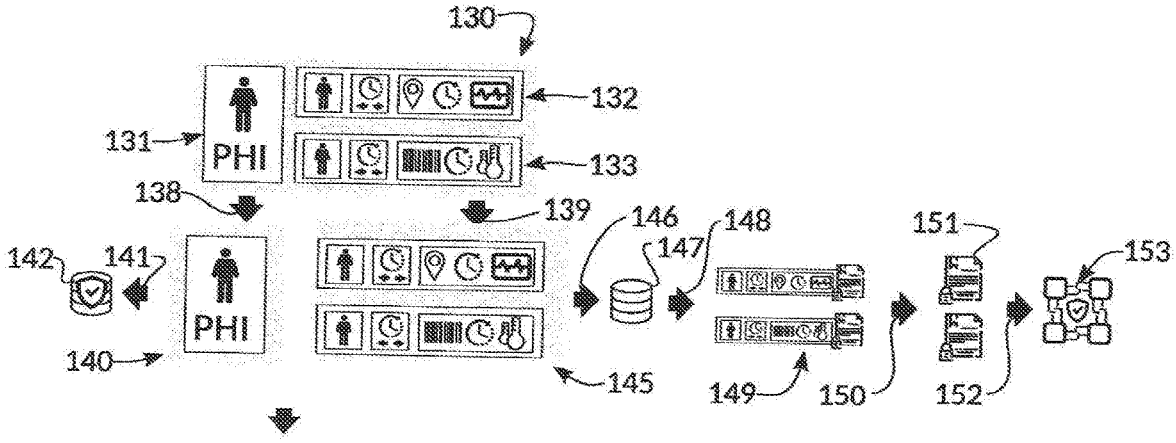

130
131
PHI
132
133
138
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142
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PHI
140
145
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152
153

Fig. 8

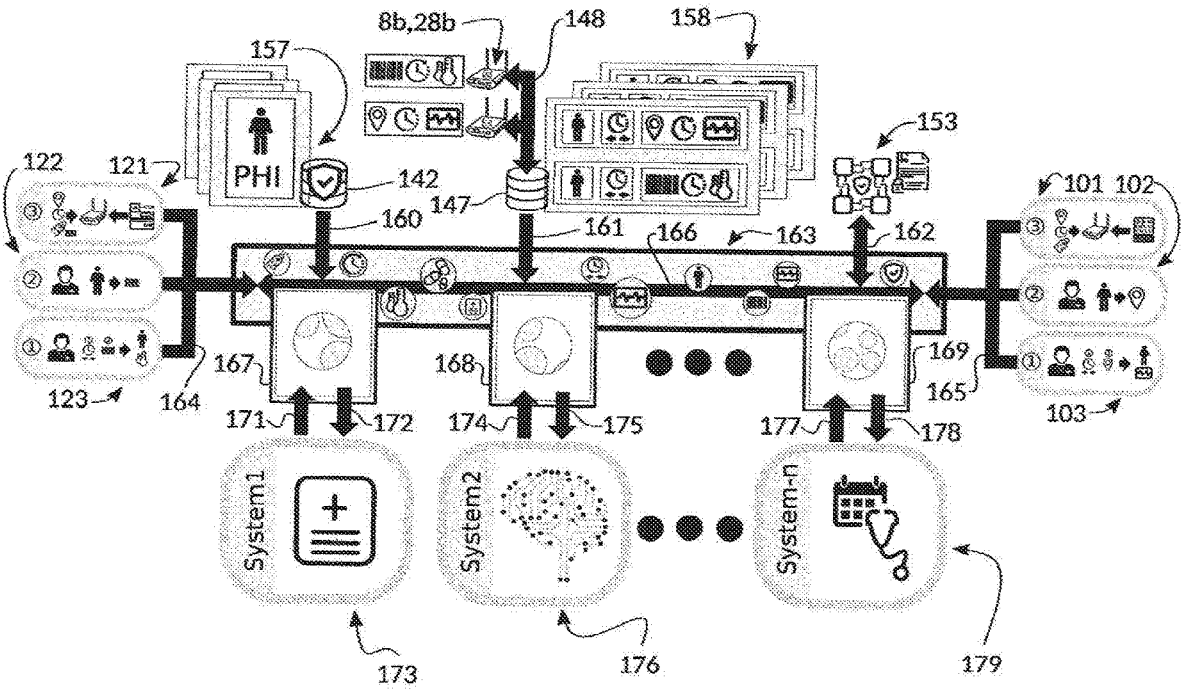

8b,28b
148
158
157
153
PHI
122
121
142
147
160
161
166
163
162
101
102
167
168
169
165
123
164
171
172
174
175
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103
System1
System2
System-n
173
176
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Fig. 9

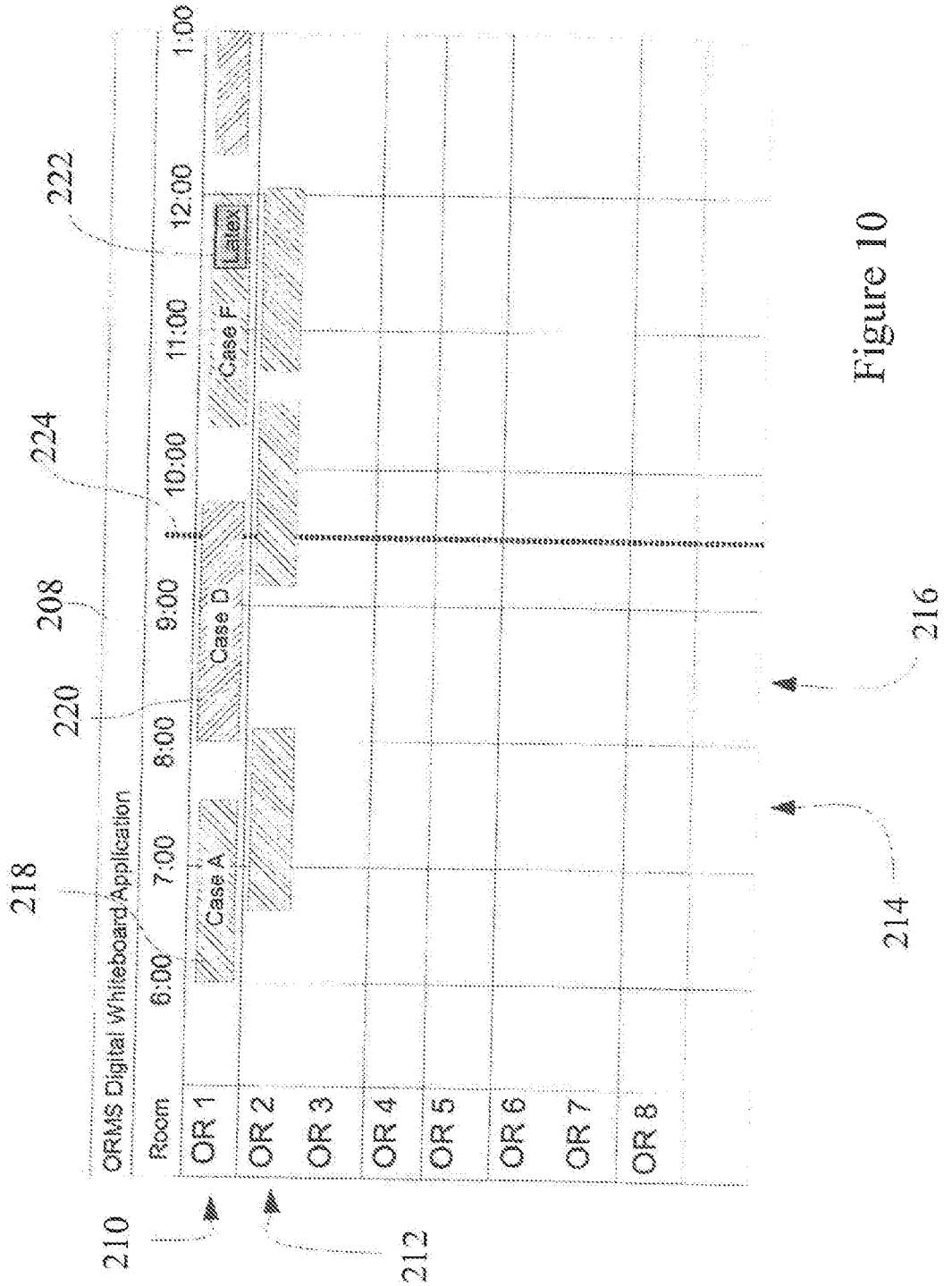

ORMS Digital Whiteboard Application
Room
6:00
7:00
8:00
9:00
10:00
11:00
12:00
1:00
OR 1
OR 2
OR 3
OR 4
OR 5
OR 6
OR 7
OR 8
Case A
Case D
Case F
Later
210
212
214
216
218
220
222
224
208

Figure 10

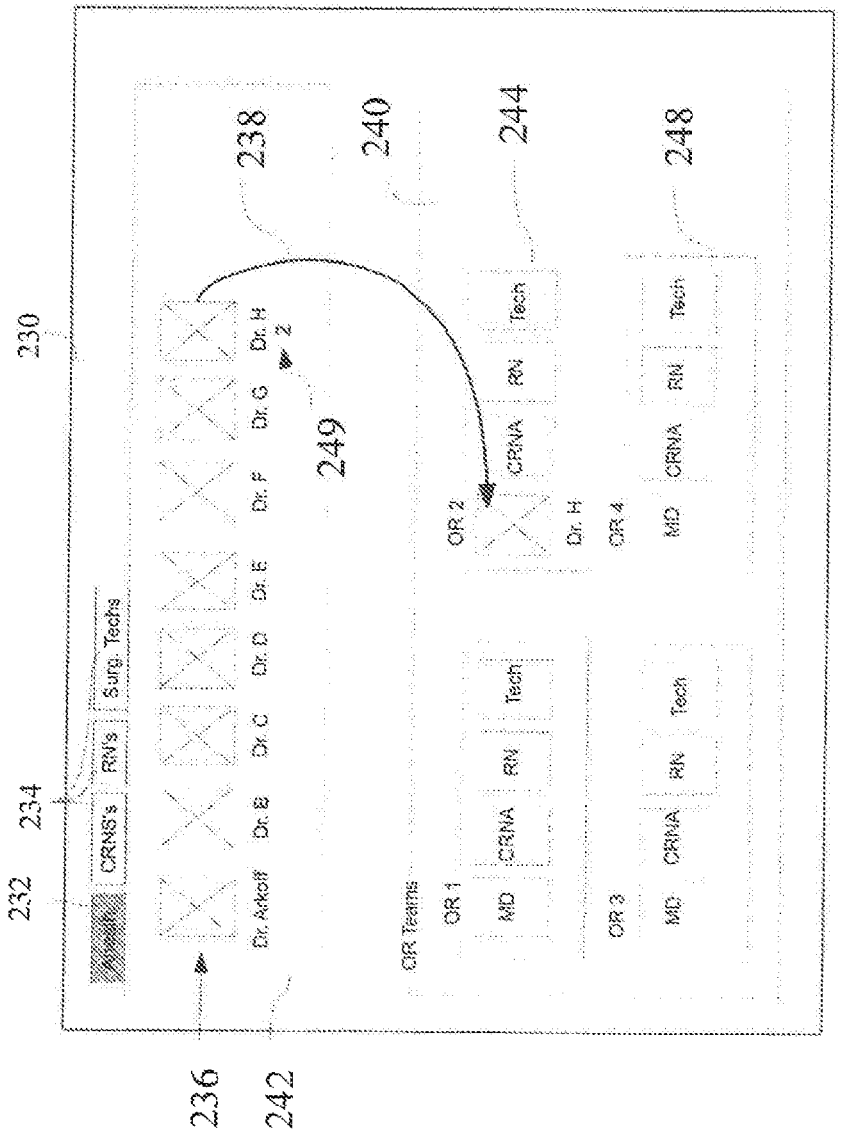

230
232
234
CRNS's
RN's
Surg. Techs
Dr. Ankoff
Dr. B
Dr. C
Dr. D
Dr. E
Dr. F
Dr. G
Dr. H
238
240
244
248
249
OR Teams
OR 1
MD
CRNA
RN
Tech
OR 2
Dr. H
OR 3
OR 4
236
242

Figure 11

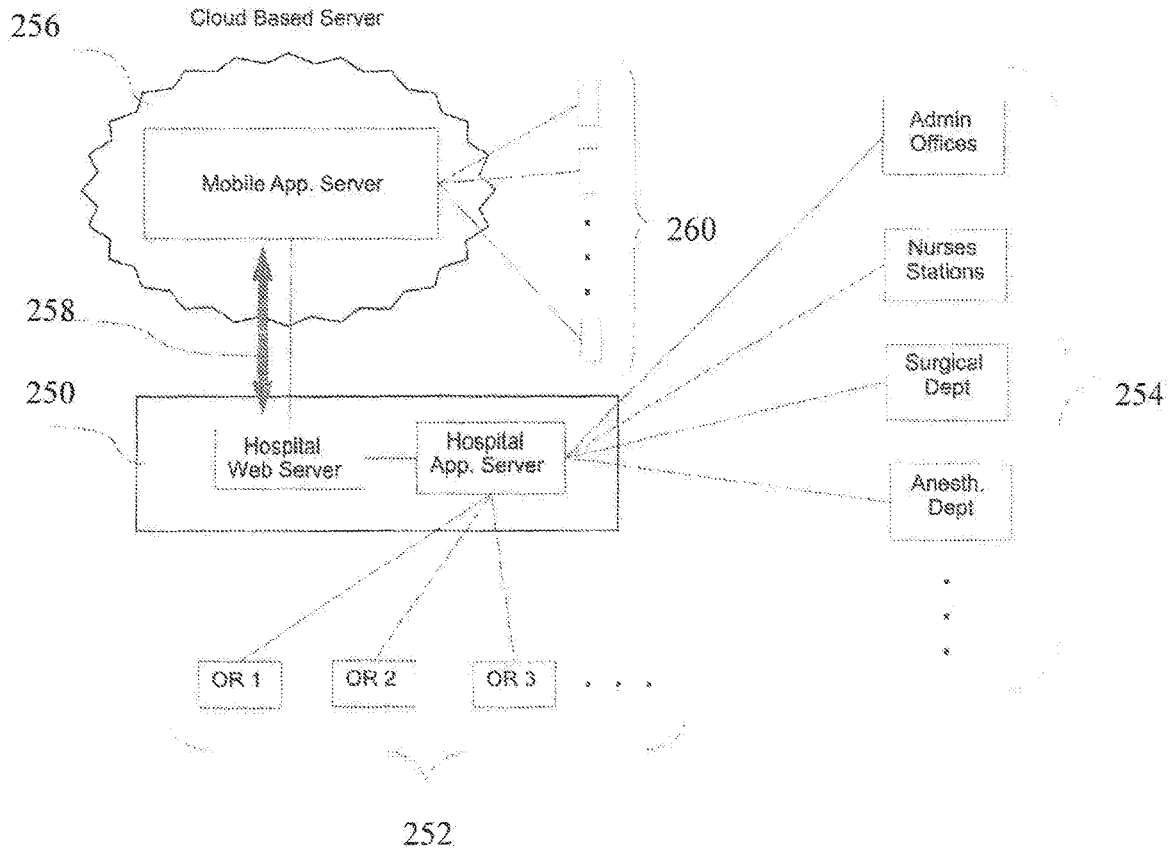

256
Cloud Based Server
Mobile App. Server
260
258
250
Hospital Web Server
Hospital App. Server
Admin Offices
Nurses Stations
Surgical Dept
Anesth. Dept
254
OR 1
OR 2
OR 3
252

Figure 12

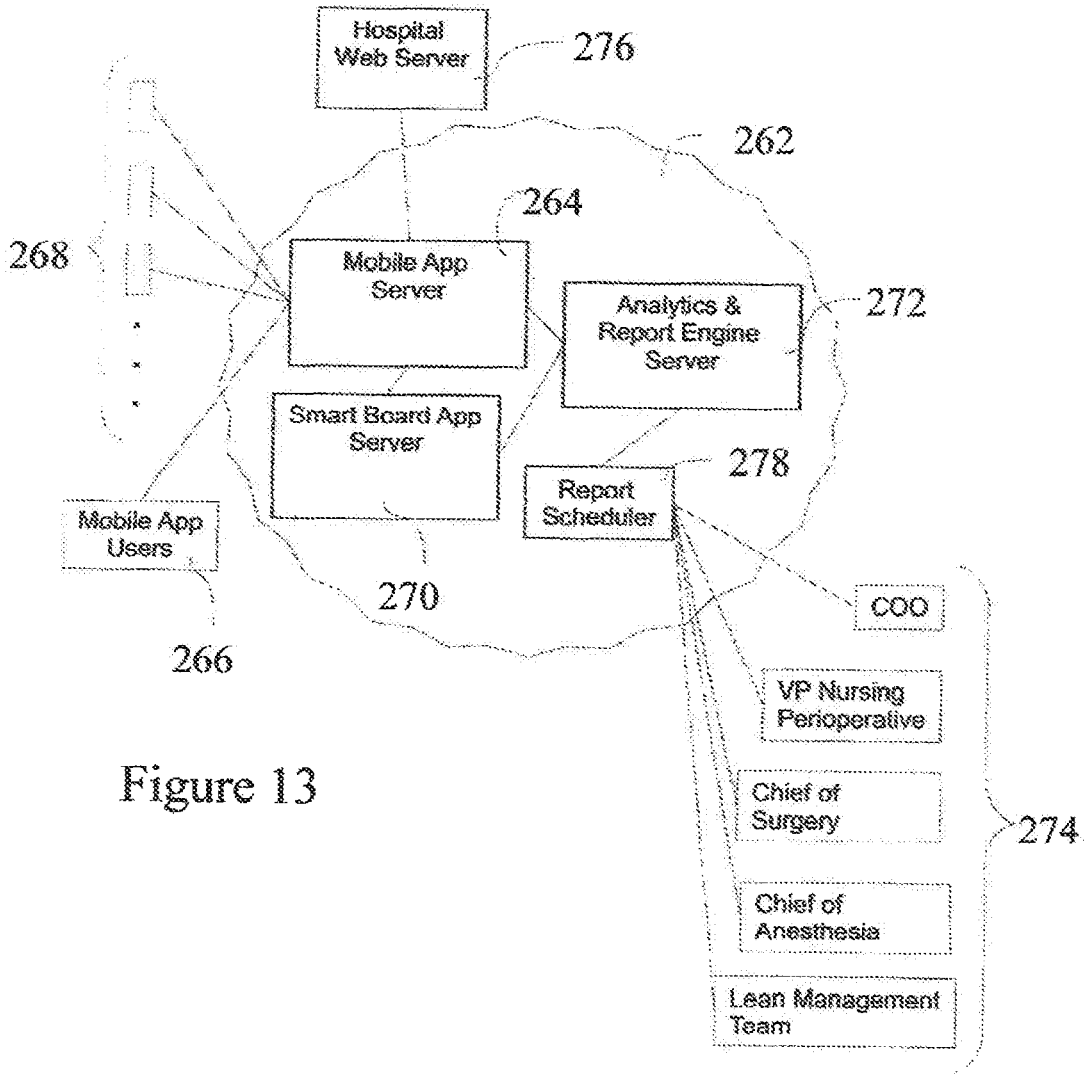

Hospital Web Server
276
262
264
268
Mobile App Server
Analytics & Report Engine Server
272
Smart Board App Server
278
Report Scheduler
Mobile App Users
270
266
COO
VP Nursing Perioperative
Chief of Surgery
274
Chief of Anesthesia
Lean Management Team

Figure 13

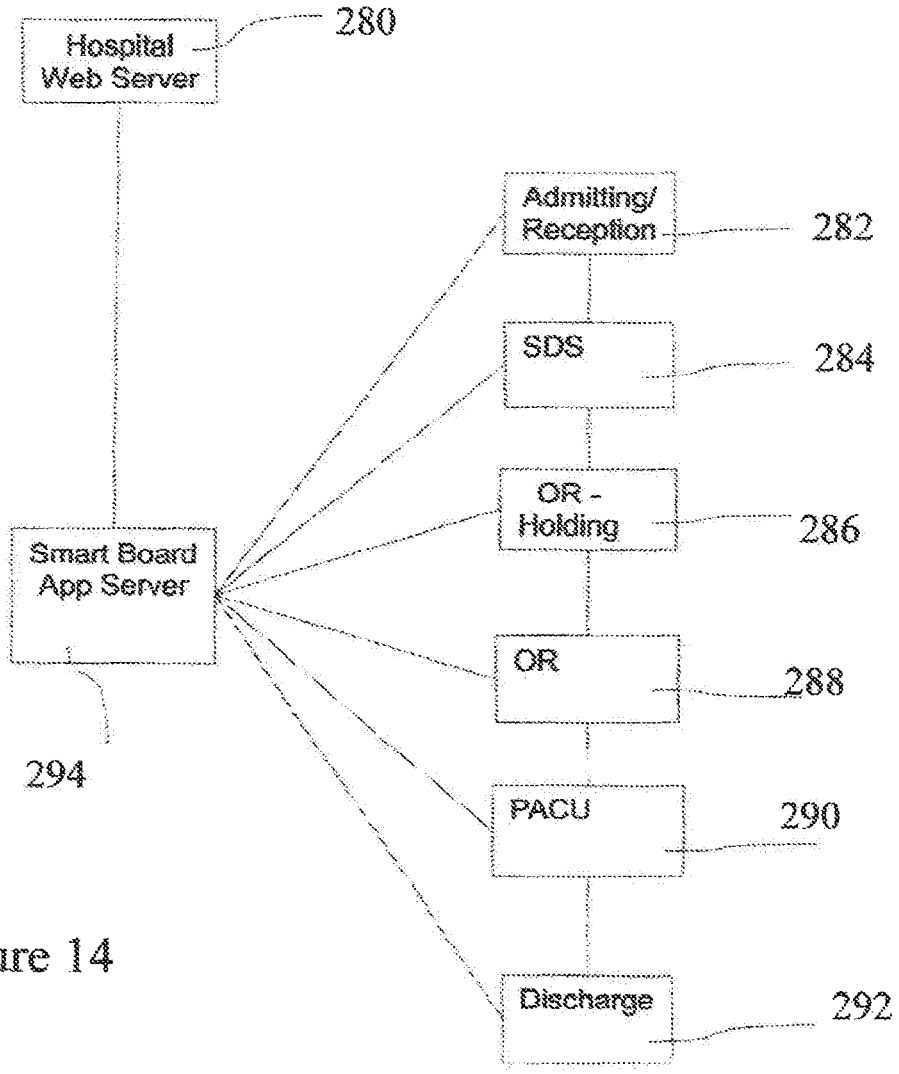

Hospital Web Server
280
Admitting/ Reception
282
SDS
284
OR - Holding
286
Smart Board App Server
OR
288
294
PACU
290
Discharge
292

Figure 14

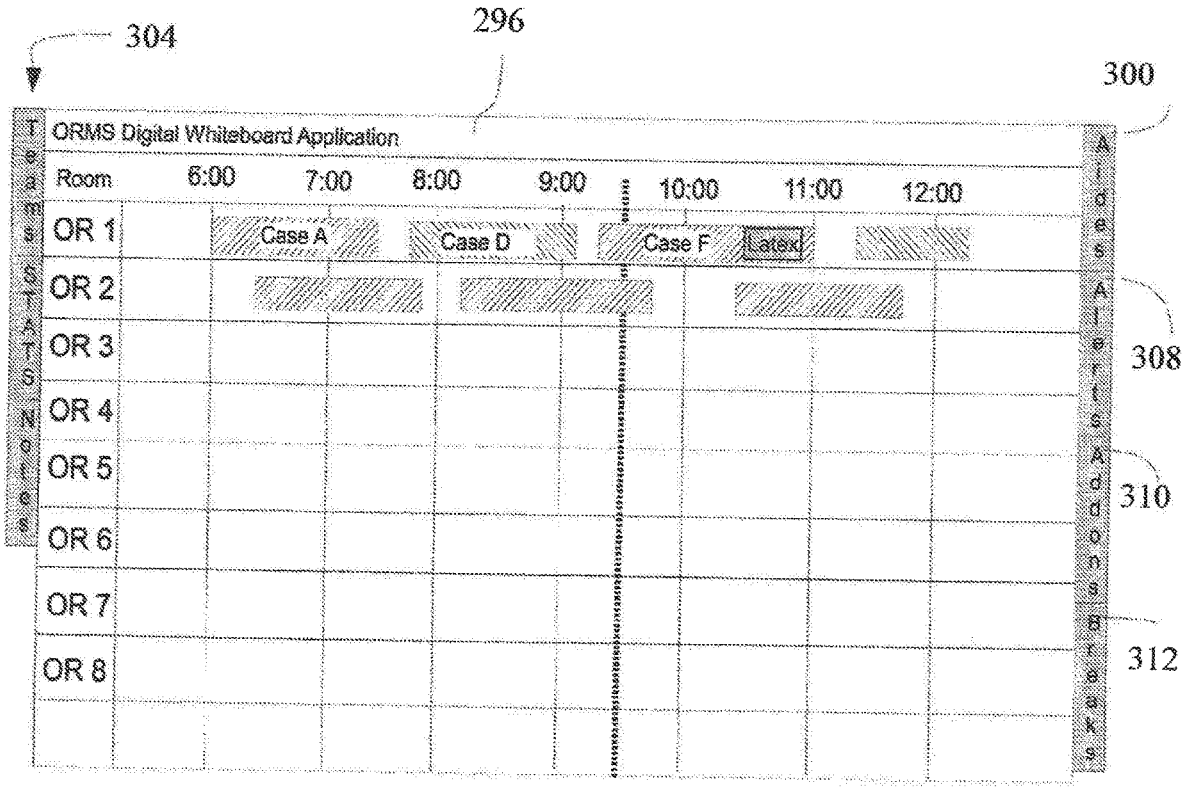

304
296
300
ORMS Digital Whiteboard Application
Room
6:00
7:00
8:00
9:00
10:00
11:00
12:00
OR 1
OR 2
OR 3
OR 4
OR 5
OR 6
OR 7
OR 8
Case A
Case D
Case F
Latex
Time Selector
Alerts Addresses
308
310
312

Figure 15

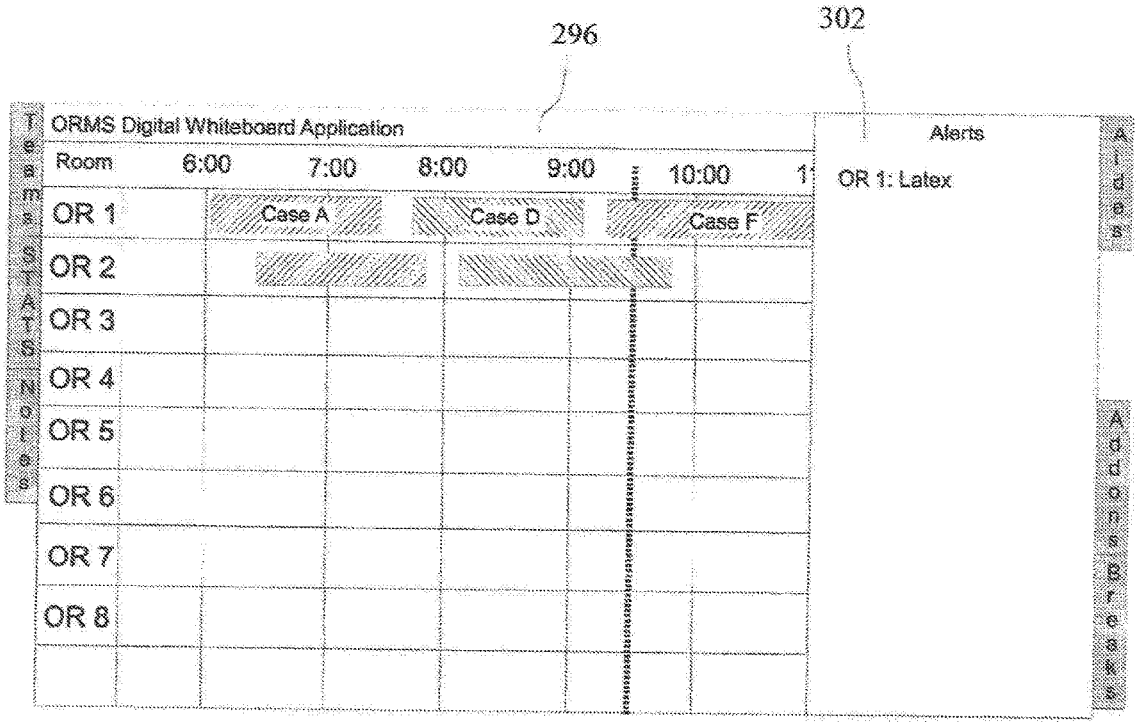

296
302
ORMS Digital Whiteboard Application
Alerts
Room
6:00
7:00
8:00
9:00
10:00
OR 1: Latex
OR 1
OR 2
OR 3
OR 4
OR 5
OR 6
OR 7
OR 8
Case A
Case D
Case F
Team Status Notes
Add Appointment

Figure 16

Figure 17

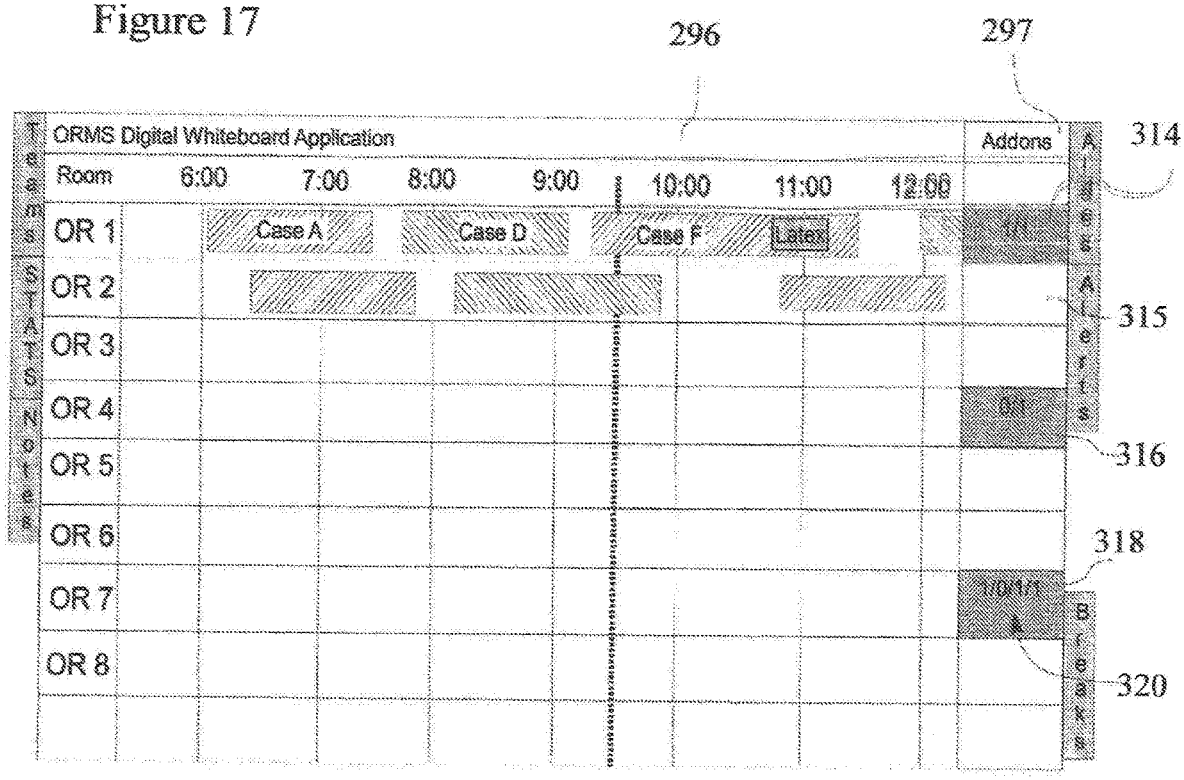

296
297
314
315
316
318
320
ORMS Digital Whiteboard Application
Addons
Room
6:00
7:00
8:00
9:00
10:00
11:00
12:00
OR 1
OR 2
OR 3
OR 4
OR 5
OR 6
OR 7
OR 8
Case A
Case D
Case F
Later
Time Slots
Addons
Blocks

Figure 18

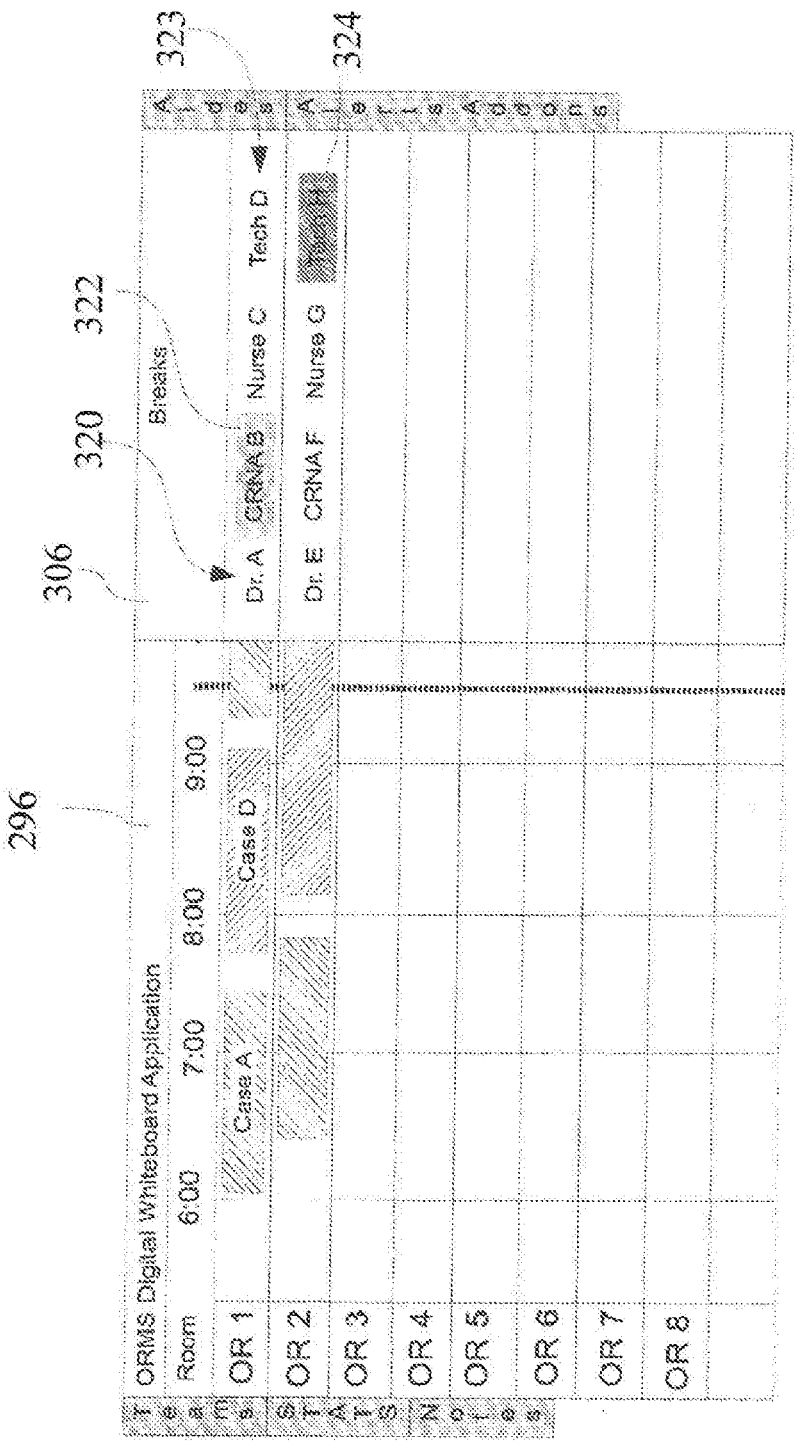
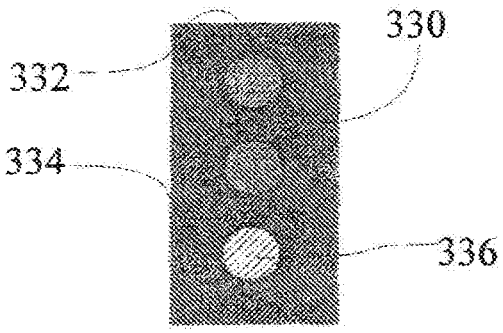

296
306
320
322
323
324
ORMS Digital Whiteboard Application
Room
6:00
7:00
8:00
9:00
OR 1
OR 2
OR 3
OR 4
OR 5
OR 6
OR 7
OR 8
Case A
Case D
Dr. A
CRNA B
Nurse C
Tech D
Breaks
Dr. E
CRNA F
Nurse G

Figure 19



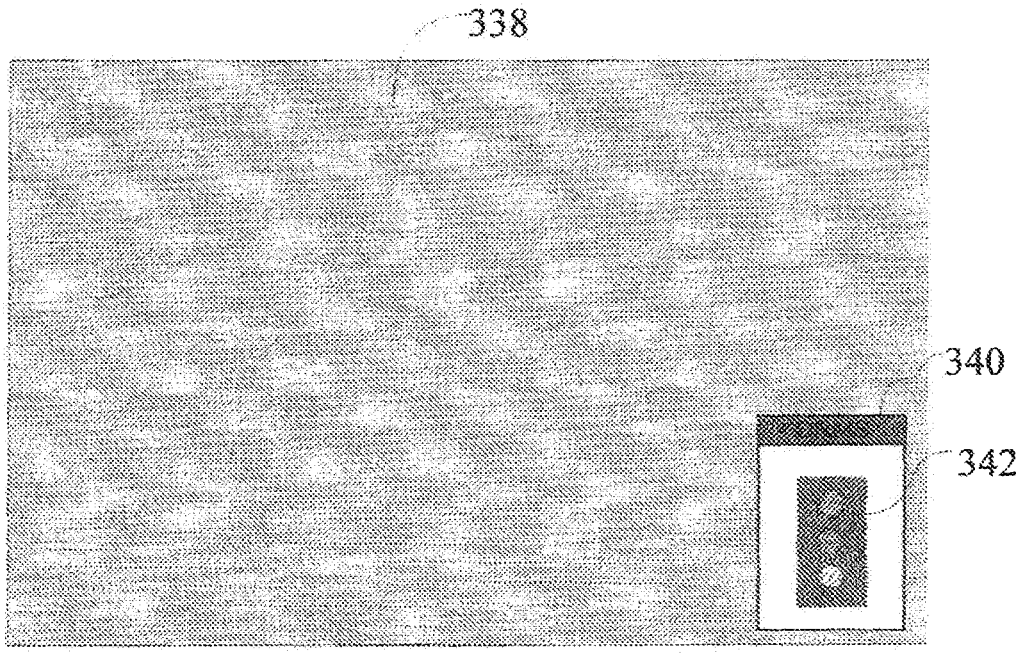


Figure 20

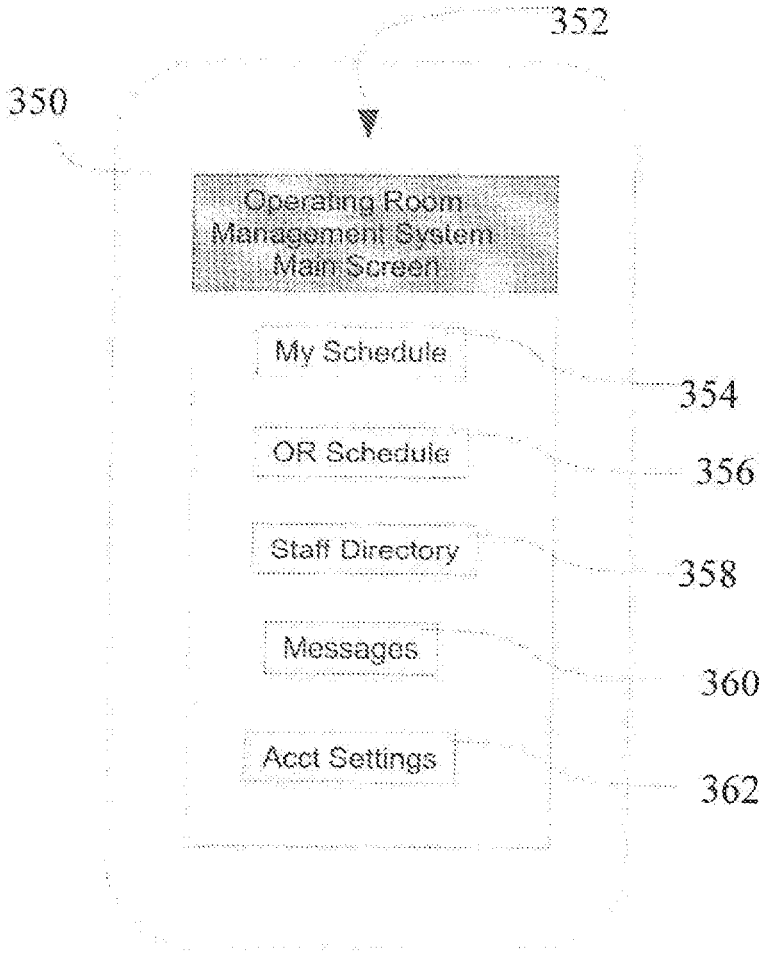

352
350
Operating Room Management System Main Screen
My Schedule
354
OR Schedule
356
Staff Directory
358
Messages
360
Acct Settings
362

Figure 21

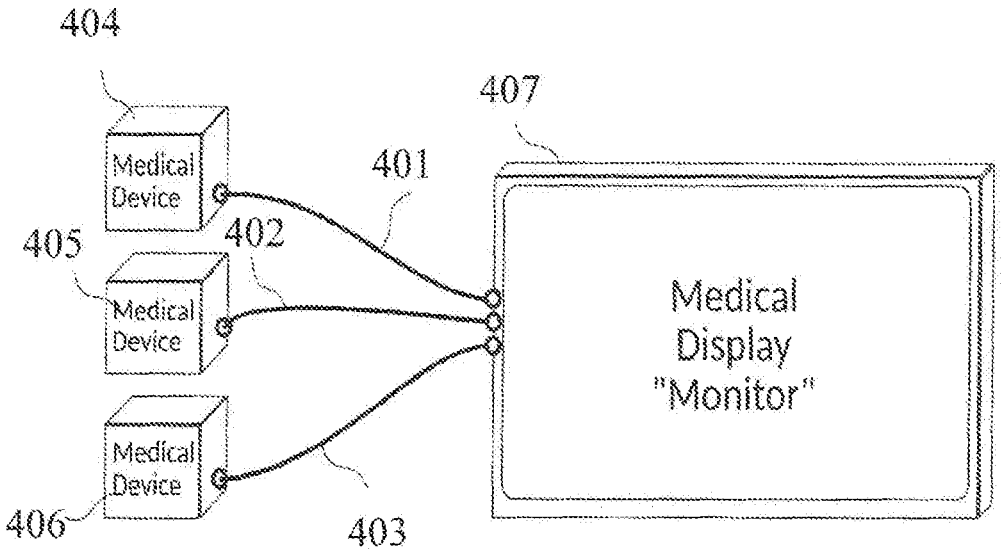


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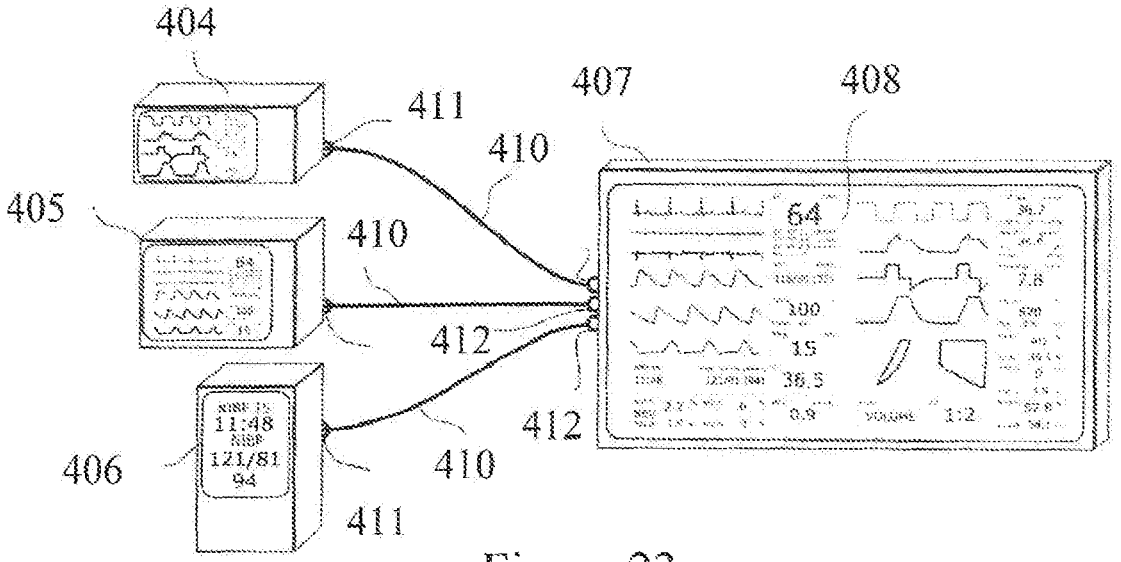


Figure 23

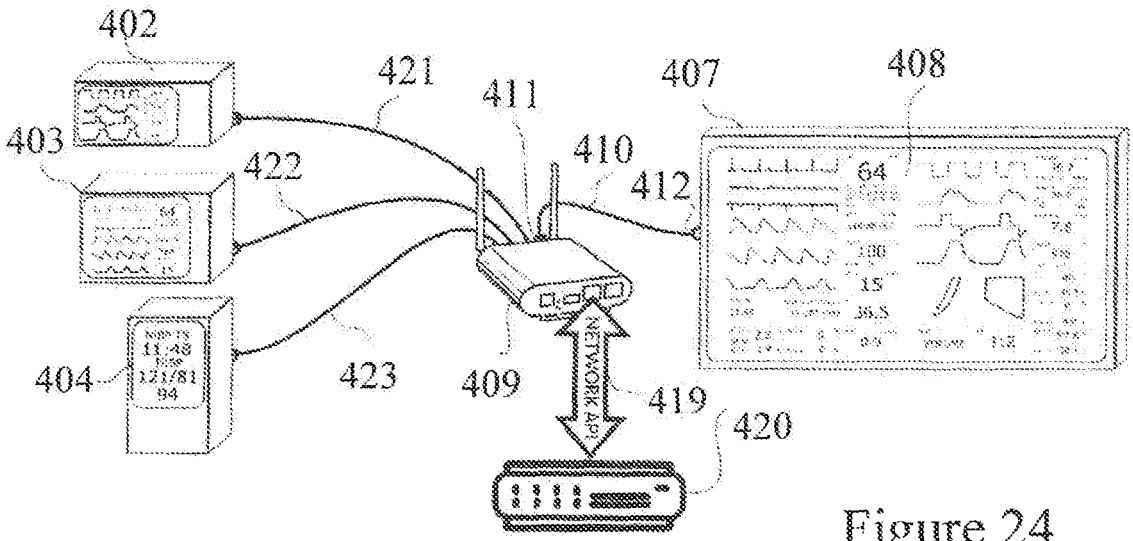


Figure 24

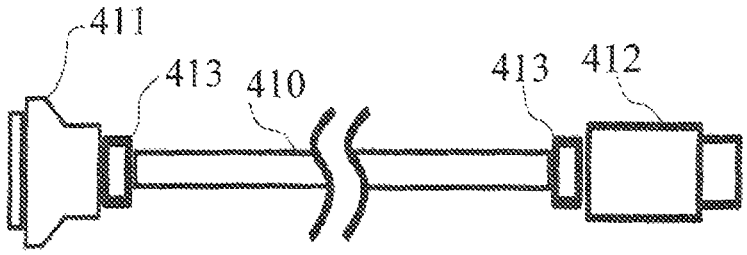


Figure 25

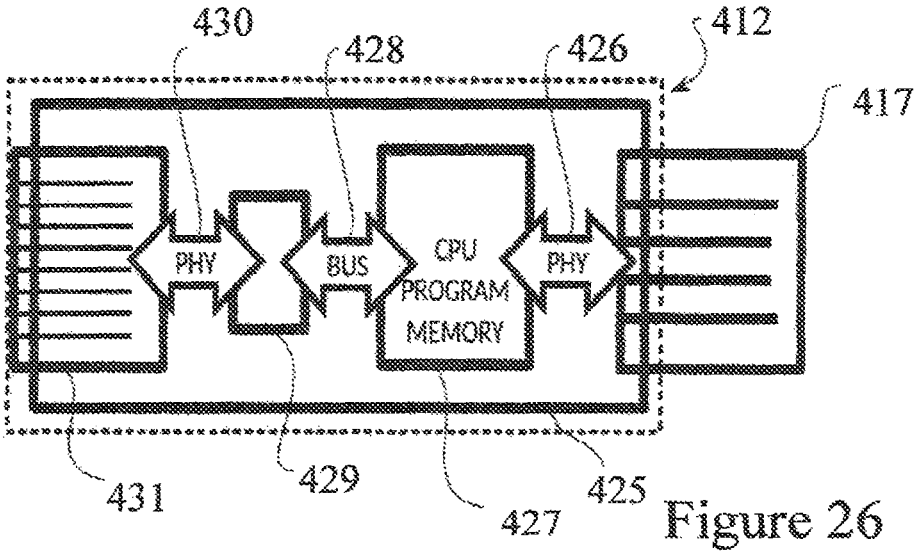


Figure 26

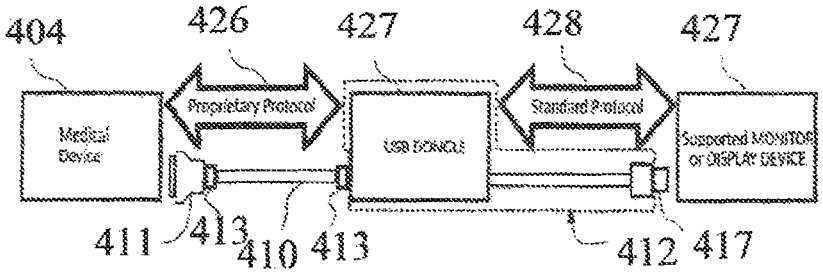


Figure 27

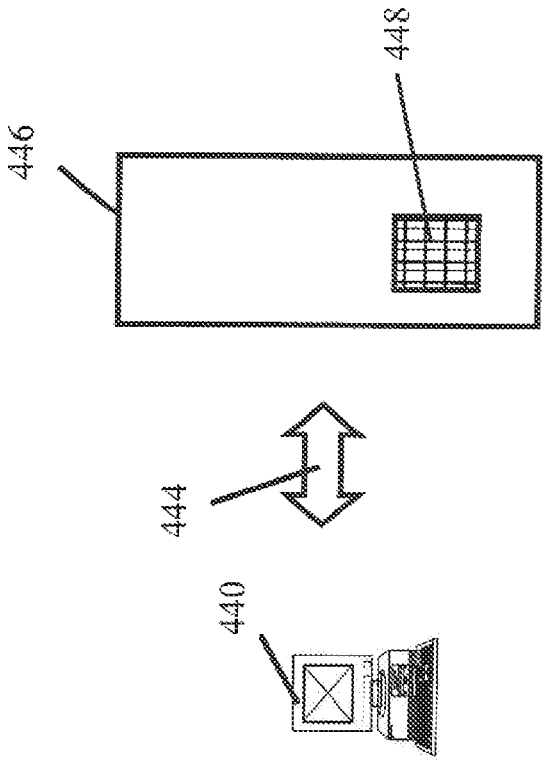


Fig. 28

COMPREHENSIVE HEALTHCARE DATA MANAGEMENT SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation in part of U.S. application Ser. No. 13/651,058, filed on Oct. 12, 2012.

FIELD OF THE INVENTION

This application relates to healthcare data management hardware and software, and more particularly to reliable medical device data intereoperability and storage in a normalized, standardized format useful for healthcare providers and medical research.

BACKGROUND

Modern hospitals are complex, technologically sophisticated organizations having sometimes thousands of employees, doctors, nurses, medical technicians and administrators, with critical life or death decisions being made regularly—and sometimes having to be made abruptly and quickly. Up-to-date, perspicuous and complete data about the patient can make a difference. And even when critical decisions are not at stake, increases in the cost of health care have made it imperative to use patient data, facility personnel and resources as efficiently as possible. Also, particular medical personnel or facility staff members may need to be alerted with respect to the updated status of particular resources or patients and may need to provide updates to the information displayed from where ever they are located.

Medical Data Governance is an approach to managing data that allows hospitals and health organizations to balance two needs: the need to collect and secure all available information while also maximizing the usefulness of that information for patient care, medical research and other valid purposes. Patient data collected during operations, other medical procedures and patient recovery is updated continually and often needs to be displayed immediately and in an efficient and speedily apprehended manner to attending medical personnel as well as being permanently retained in a standard format useful to facility management and medical researchers among others who may be in remote locations and/or need to compare data from myriad healthcare facilities.

Nowadays governments try to limit legal collection of personal data through various privacy protection acts. By doing so, they limit the collection of data for future research or for validation at the time of data collection. Medical Data Governance (MDG) absolves the important role of governing the process of acquisition, patient identification, provider identification, data validation, time synchronization, localization of different, non-homogeneous clinical, medical, medical relevant, and patient relevant data from isolated, standalone medical devices or networked devices. MDG fulfills the need for a true and complete source of data for other consumers of medically relevant data, such as Electronical Medical Records, Health Medical Records, Artificial Intelligence systems, Machine Learning systems, research, trials, Decision Support Systems, data recording and so on. The process of collection, normalization, association of data, along with source localization, type, quality and anonymous metadata, allow customizable subsets of data to be provided to different accredited users, systems and endpoints. Some of the use cases of MDG are innovative,

and some represent a more efficient, cost effective methods compared to already existing procedures or methods.

Artificial Intelligence and Machine Learning systems require a medical data governance middleware to assure proper, normalized and verified data inputs. Legacy health information systems and electronical medical records were designed to receive only a portion of the exponentially increasing data medical devices can create and can be collected. Further, outdated HIS/EMR (Healthcare Information Systems/Electronic Medical Record) and inadequate patient identification and association can cause a serious bottleneck for data-hungry personalized medicine, real time applications, and in practice, most medical device data are not recorded at all. And yet as shown in recent studies it can be easy to identify individuals even from anonymized data https://www.nytimes.com/2019/07/23/health/data-privacy-protection.html.

In another aspect of the invention, hospitals and other healthcare facilities providing surgical services must coordinate a myriad of resources, medical personnel, and hospital staff to provide optimum and efficient care to their patients. Information about status of these resources and the facilities' patients must be updated constantly and be available to the relevant medical personnel and facility staff in the operating rooms (ORs) where the surgical services are delivered, in other ancillary rooms of the facility, and to medical personnel and facility staff who may be in remote locations. Particular medical personnel or facility staff members may need to be alerted with respect to the updated status of particular resources or patients and may need to provide updates to the information displayed from wherever they are located.

U.S. Pat. No. 5,842,173 to Strum et al., issued for "Computer-Based Surgical Services Management System," describes a complex database running on a server and display system to coordinate surgical services at a medical center, but it is updated only periodically, not continuously. It also does not provide for remote notification and interaction by the medical center personnel.

In another aspect of the invention, in typical hospital settings such an operating room, ICU, recovery room etc., there are multiple medical devices surrounding a patient. For convenient, efficient assessment of the data collected and to control these devices, it is helpful to have their associated data displayed on a single monitor to have all the relevant information on a "single piece of glass". To achieve this, typically, a medical gateway (typically a general purpose PC computer) is setup to receive data from all the surrounding devices, convert the data to a standard format, synchronize it, and arrange for its display on a monitor proximate. But general purpose PCs, despite being commonplace, are actually an exceedingly varied and complex group of devices, each needing a specific setup and configuration, and ongoing maintenance of both software and hardware to maintain system security and efficiency. Simply put, the maintenance of general purpose PCs dedicated to data display ends up being a substantial expense for hospitals.

Biondi et al, U.S. Pat. No. 8,886,792B2, and Gao-Saari et al, U.S. Pat. No. 8,225,015B2, show the complexity and criticality of providing an integrated display from multiple heterogeneous medical devices in various circumstances, but provides no simple, stable, inexpensive solution for any specific hospital setting.

SUMMARY

In accordance with the present disclosure, embodiments of a system, method, and apparatus are described which

OSSI Ex. 1016

eliminate or ameliorate the problems and disadvantages associated with previous systems, methods, and apparatuses.

Due to the exponential data availability from growing health-related devices, the risk of data not being collected, or worst, being wrongly associated, grows exponentially. In particular embodiements, the MDGS opposes this trend by using the same data to augment the data affinity and isolate and indicate possible association or data integrity errors.

When errors are detected from automated systems or from a later check or evidence, errors are propagated through related data, and when the data, a wrong association or time reference is corrected and signed with block-chain, the whole time segment of the data must be resent to the subsystem. Particular embodiments include the MDGS as the True and Complete Source of Data which should be used as the front end for subsystems.

By concentrating all available medical relevant data into a single source, and providing a subset of data to each receiving subsystem with the correct source and time reference, the Medical Data Governance System becomes the True Source of Data and guarantees the data consistency through the use of block chain signatures.

The instant invention provides a simple, stress-free, inexpensive connection and data-combining scheme requiring no special effort or consideration on the part of the medical personal attempting to care for patients in a wide range of hospital settings.

In another aspect of the invention, a system of servers is provided, which communicate data in real time with white boards stationed in the operating rooms of a healthcare facility. Medical personnel and healthcare facility staff members can view the formatted data on a white board and input new or revised data directly on the white board or at an input station near the white board.

Further in this embodiment, mobile phones carried by medical personnel and healthcare facility staff run applications enabling the real time display of data communicated by the servers and allowing the input of new or revised data into these mobile phones to be transmitted to the servers and displayed when appropriate on whiteboards and other displays throughout the facility. The mobile phone applications further permit the alerting of specific personnel, other mobile phone carriers and throughout the facility.

In another aspect of the invention, the problem of long-term reliable, secure connections to multiple heterogeneous medical devices and combining the displays of the data they produce for efficient apprehension is solved. The instant invention provides a simple, stress-free, inexpensive connection and data-combining scheme requiring no special effort or consideration on the part of the medical personnel attempting to care for patients in a wide range of hospital settings.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present disclosure and its advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, in which like reference numerals represent like parts.

FIG. **1** is a block diagram overview of a Medical Data Governance system (MDGS) according to an embodiment of the invention.

FIG. **2** is an illustration providing high-level detail about each layer of the MDGS pyramid of FIG. **1**.

FIG. **3** is an illustration of the details of continuous patient monitoring measurement, part of the first layer of MDGS, Digital Black Box Recording, in an embodiment.

FIG. **4** is an illustration of the details of the recording of sporadic patient related data, part of the first layer of a MDGS, Digital Black Box Recording, in an embodiment.

FIG. **5** is an illustration of the details of providing block chain signatures for black box recorded patient data sets in an embodiment.

FIG. **6** is an illustration of the details of black box recording of a variety of different types of patient data in an embodiment.

FIG. **7** is an illustration of the details of the second layer of a MDGS, Positive Patient Identification and Data Verification in an embodiment.

FIG. **8** is an illustration of the details of the process of storing Protected Healthcare Information (PHI) and providing a PHI data set with a block chain signature.

FIG. **9** is an illustration of the details of the third layer of a MDGS, data extraction and export, in an embodiment.

FIG. **10** is an illustration of a hospital daily schedule display on an operating room digital white board.

FIG. **11** is an illustration of the team building display on an operating room digital whiteboard in an embodiment of the invention.

FIG. **12** is a block diagram detailing the arrangement of specific servers in an embodiment.

FIG. **13** is a block diagram illustrating the arrangement of specific servers within the cloud server in another embodiment of the invention.

FIG. **14** is a block diagram illustration of patient movement through the hospital and corresponding data entry.

FIG. **15** is an illustration of tabs on the daily schedule display indicating the availability of viewable side panels.

FIG. **16** is an illustration of a displayed side panel on the daily schedule display.

FIG. **17** is an illustration of a second displayed side panel on the daily schedule display.

FIG. **18** is an illustration of a third displayed side panel on the daily schedule display.

FIG. **19** is an illustration of a stop light alert icon in an embodiment.

FIG. **20** is an illustration of a stop light alert icon in a small window on the desktop display of an administrator.

FIG. **21** is an illustration the main navigation display on the smartphone running the ORMS app of an embodiment.

FIG. **22** is a block diagram of an embodiment of the invention wherein three active cables, each connected to a medical device, are plugged into a conventional monitor.

FIG. **23** illustrates the combined data displayed side-by-side and synchronously on a conventional medical monitor or from three medical devices connected to the monitor with active cables in an embodiment of the invention.

FIG. **24** is a diagram illustrating the connection of three medical devices with active cables to an IoT device enabling transmission of the medical device data to a remote server for permanent storage and/or analysis.

FIG. **25** is a block diagram showing the details of the physical construction of an active cable arrangement in an embodiment.

FIG. **26** is a block diagram illustrating the details of the logical processing capability of an active cable arrangement in an embodiment.

FIG. **27** is a block diagram illustrating the overall system and processing sequence in an embodiment.

FIG. **28** is a graphical representation of the method of the invention in an embodiment illustrating the interconnection

OSSI Ex. 1016

of the various computing resources necessary to produce the active cable arrangement of the invention.

DETAILED DESCRIPTION

FIG. **1** is a block diagram overview of the three functional layers of a Medical Data Governance System (MDGS) in an embodiment. The base layer **201** is digital black box recording of patient data. The middle layer **202** is positive patient identification and data validation. The top layer **203** is true source data and data export for research and other purposes.

Binding Location (geo-localization, indoor localization), Time, Provider, Patient is associated with data obtained from isolated or networked medical and medical relevant devices. The MDG collects data from medical devices, identifies them, normalizes and time synchronizes all the data outputs while storing them safely, with tamper detection methods (such as blockchain) local to the source of data. Partial and/or metadata about the collected data are used to identify the related patient, patient location, patient provider, source of data and location from whom the data had been collected when available. In the process described as MDG, the normalized data along with time, time span, location, patient are securely stored and saved for data export into third party systems (data consumers) or stored for later export. The process of binding Location, Time, Provider, Patient to the data can occur pre or post data collection, generating new dataset at each intervention or association, creating incremental dataset groups. For example, complete patient association can be done hours or days after the data had been collected, as well preset before the data is collected from the medical device.

Patient Treatment Time Optimization and Device Asset Management

MDG provides a true source of data that can highlight the schedule time variations of exams and other medical treatments and provides tools for the rescheduling feedbacks, contacting and receiving feedbacks from patients/physician/healthcare professionals thus introducing general system flexibility through the use of lean process and six sigma methods.

MDG leverages modern communication methods (phone apps, emails, web services . . .) and easily links patient and physician/other healthcare professionals to the scheduled use of medical devices. After unexpected events that may cause a miss in scheduled operations, the MDG may create a backup schedule to preemptively fill the gaps and may facilitate healthcare and schedule professionals to optimize machine time usage. This could create a new marketplace for priority services for those patients that opt for it.

Patient/User Data Monetization by Patient/User, Institution or Combination Of

MDG enables patients/users and or Institutions to monetize their vitals, medical relevant, patient data collected during the stay inside the healthcare institution, as well through the extended data collected over period of time in a multiple stays or spot measurements in healthcare institutions. Patients could establish a relationship with a third party (such as drug manufacturer, independent drug trails projects, undisclosed trails to the institution) and provide to the third party normalized data collected, organized and provided by the MDG used by the healthcare institution, and provided to the patient in different standardized format, even in near real time. The institution might not be aware of the final user of the patient data. MDG can create additional revenue to the institution by charging such a service per patient and per data processed. MDG can track and trace data usage per patient and assets. MDG through the export of all specific, validated clinical data, medical relevant data, could create a new data-based economy.

Patient Notification and Pre or Post Consent of Data Use for Second Opinions, Medical Treatments, Specific Research, Validation, Education or Application.

MDG is solving the problem of giving consent and approval, or notification for use of the patient data for second opinion, medical treatments, specific research, validation project, educational purposes. Specific patient or user data is previously screened based on always updated, public, generic, anonymous metadata (for example: sex, age, days in hospital, normalised data content and length: heart rate, respiration rate, drugs . . .)).

MDG can handle patient consent using modern communication methods (phone apps, emails, web services . . .) and provide patient consent for his data to be used in a specific research or validation project, with or without compensation. MDG can provide patient consent and access to the data to specific users, like doctors, physician, and other specific medical professionals. MDG can provide specific code associated to the data, that, based on necessity, can provide, if granted by the user or proxy consent, provide protected personal identification, family relations or other protected personal data.

Research Dataset Optimization

MDR allows for third party statistical analysis (research) on the whole population dataset, without exporting or providing data to the third party, but rather comparing the result to the legally available consent subset group. A statistically relevant result might indicate a minimal group of statistically significant subset of data to search consent and optimize the time for valid and repeatable dataset.

Data Normalization

Data normalization appears to be a key element for application of Artificial Intelligence in Healthcare. MDG, through the acquisition of higher frequency (sub-minute/sub-seconds), high fidelity data, patient identification, provider identification, data validation, time synchronization, localization of different, non-homogeneous clinical, medical relevant, patient relevant data from isolated, standalone medical devices or networked devices, can provide a superior, in terms of quality and quantity, subset of normalized data.

Metadata

MDG collects and stores all available data from any potentially source of data, localizes and time synchronizes all data points. Metadata such as, healthcare provider, environment temperature, hours of operation of medical device, time from last service, related errors can provide almost endless source of data for future use or research.

An Overall Solution to the Lack of Standards and Interoperability

MDG, as a sole purpose of true source of data, and without any specific end user purpose serves as a interoperability and standardization tool, enabling the health industry to leverage stored data through new and old standards based on the need.

Root-Cause Analysis and Quality Improvement Classification

As a most complete data gathering and presentation tool, any adverse case or event can be studied up to the maximum details reordered by the MDG. MDG tools helps retrieving patient identification, provider identification, data validation, time synchronization, localization of different, non-homogeneous clinical, medical, medical relevant, patient relevant data after adverse events, providing tools for ana-

OSSI Ex. 1016

lyzing risks, therefore introducing quality, process, outcome improvements. This classifies MDG as a quality improvement tools, therefore protected from legal perspective to be used as a proof of malpractice or errors.

Non-medical user notification and pre or post consent of data use for specific research, validation, education, marketing or application. The ability of handling critical data can be extended to several personal user data in different fields outside of medical.

MDG solves the problem of giving consent and approval, or notification for use of the user data for specific research, validation project, educational purposes, marketing or application. Specific user data is previously screened based on always updated, public, generic, anonymous metadata (for example: sex, age, days in hospital, normalised data content and length). MDG can handle user consent using modern communication methods (phone apps, emails, web services . . .) and provide user consent for his data to be used in a specific research or validation project, with or without compensation.

FIG. **2** is an illustration of a simplified 3-layer MDGS in an embodiment. Artificial Intelligence and Machine Learning systems require a medical data governance middleware to assure proper, normalized and verified data inputs. Legacy health information systems and electronical medical records were designed to receive only a portion of the exponentially increasing data medical devices can create and can be collected. Also, outdated HIS/EMR (Healthcare Information Systems/Electronic Medical Record) and inadequate patient identification and association can cause a serious bottleneck for data-hungry personalized medicine, real time applications, and in practice, most medical device data are not recorded at all.

Layer (1): Black Box Recording

Hospital medical devices, continuous monitoring systems and laboratory devices **53**, **66**, through the use of proper physical and software drivers **7**, **27** are collected by Medical Device Data System (MDDS) devices **8**, **28** and location/time synchronized, optionally signed with block chain service, and made available to the second layer of the MDGS—Positive Patient Identification and Data Validation.

Similar to laboratory devices, video **92** can be transferred **93**, recorded **94**, location/time synchronized, and then transferred when convenient **95** to a central repository and patient locked by the second layer. Wearables and home or community care data and sensors **84**, generally available through BLE (Blue Tooth Low Energy, BT4.1) wireless protocol **85**, can be registered and time synchronized by portable MDDS device or phone application **86**, and available or optionally transferred **87** when possible to a central repository.

Professional notes, comments, orders and communications, generally known as Journaling, **74**, **76** can be tracked, reported and stored **77**, **79** via third party systems and solutions.

Drug Distribution, Administration and all other third party software and systems **181**, **182**, **183** can be tracked, tagged, stored, time synchronized and made available **184** to the second layer.

Each MDDS has a location **101** and metadata configuration panel available for setup **121** so the medical device data can be location or patient tagged for patient data association and data validation.

Layer (2): Positive Patient Identification (PPI) and Data Validation (DV)

As described below in more detail in the description of FIG. **5**, PPI and DV depends on previous location and metadata setup of MDDS **121**, **101** (FIG. **2**) and proper data entry of metadata **122** or location **102**, and active healthcare professional confirmation of patient location time presence **103** or the proper patient identification process **123**. Upon PPI and DV, different segments of Digital Black Box recordings are patient and time segment tagged **163** and available to the third layer, True Source of Data and Data Export.

Layer (3): True Source of Data and Data Export

By concentrating all available medical relevant data into a single source, and providing a subset of data to each receiving sub-system **173**, **176**, **179** with the correct source and time reference, the Medical Data Governance System becomes the True Source of Data and guarantees the data consistency through the use of block chain signatures.

Due to the exponential data availability from growing health-related devices, the risk of data not being collected, or worst, being wrongly associated, grows exponentially. The MDGS opposes this trend by using the same data to augment the data affinity and isolate and indicate possible association or data integrity errors.

The MDGS, as the True and Complete Source of Data, should be used as the front end for sub-systems. When errors are detected from automated systems or from a later check or evidence, errors are propagated through related data, and when the data, a wrong association or time reference is corrected and signed with block-chain, the whole time segment of the data must be resent to the sub-system rather than those subsystems being corrected independently.

Each medical subsystem **173**, **176**, **179** is designed to receive specific data with a specific frequency, quantity and quality. Sometimes the specific data, frequency, quantity and quality do not overlap between subsystems. From the Complete True Source of Data, the specific export drivers **171**, **172**, **174**, **175**, **177**, **178** collect, filter, consistency check, transform and deliver appropriate data to each subsystem.

FIG. **3** is a block diagram illustrating details of one component of Layer (1) Digital Black Box Recording, in particular, the medical devices that measure continuous patient data, such as Multiparametric Patient Monitoring, Anesthesia machines, EEG and similar belonging to the "continuous" group of potentially retrievable medical data **4**, where the session beginning, duration and therefore, its end can be associated using continuous, complete data flow without data interruption **6**. Previous idle, non-patient data that is irrelevant and does not provide any information, except the fact that at that time patient data was not being collected is noted **5**. Metadata such as device not ready, cable disconnected, device powered off is recorded **2**, including but not limited to room temperature and pressure, video, and other environment data if and when available such as other medical devices connected **3** that provide essential information about the start and stop of the data valid session **6**. Medical devices **1** usually have one or more data export mechanism **7** which is used from a Medical Device Data Systems (MDDS) **8***a* to extract and collect ALL possible data, along with metadata **2**, **3** from specific software and hardware drivers and interfaces **9** and along with previously associated **10** location, metadata and clocktime **11** reference.

The MDDS stores **16** location sessions **15** with all medical data collected, metadata, timestamps and location identifiers **13** and keeps it for a limited time, for example up to 24 hours, before it copies it **20** to a centralized repository **18**. Empty, non-relevant data **14** are simply not propagated and ignored.

The MDDS **8***b* can serve a complete time synchronized and location subset of near real time data **17** without intermediary subsystem, or if the complete dataset had been

copied to a centralized repository **18**, the past data subset **19** can be retrieved from the repository services **18**.

FIG. **4** is a block diagram illustrating details of another component of Layer (1) Digital Black Box Recording, in particular, medical devices that measure sporadic patient related data **21** such as Blood Gas Laboratory Machines, Generic Laboratory Devices, Portable Non Invasive Blood Pressure devices, Scales and similar belonging to the "spot" group of potentially retrievable medical data **24**. The session beginning, duration and result can be directly associated from meta-data, such as bar code patient ID, Point Of Care (POC) input, and the result **26**. Previous idle, non-patient data that is irrelevant and does not provide any information is not propagated, except for the metadata indicating that at that time patient data results were not being collected **25**. Metadata is included such as, but not limited to, Patient Bar Code ID, POC input, device not ready, cable disconnected, device powered off **2**, but also room temperature and pressure, video, and other environment data such as other medical devices connected **3** that provide essential information about the start and end of the result data **26**. Medical devices and

Laboratory devices **21** usually have one or more data export mechanism **27** which is used from a Medical Device Data Systems (MDDS) **28***a* to extract and collect ALL possible data, along with Metadata **22**, **23** from specific software and hardware drivers and interfaces **29** and along with previously associated **30** location, metadata and clock-time reference **31**.

The MDDS stores **36** location sessions **35** with all medical data collected, metadata, timestamps and location identifiers **33** and keeps it for a limited time, for example up to 24 hours, before it copies it **40** to a centralized repository **38**. Empty, non-relevant data **34** are simply not propagated and are ignored.

The MDDS can serve a complete time synchronized and location subset of near real time data **37** without intermediary subsystem, or if the complete dataset had been copied to a centralized repository **38**, the past data **39** subset can be retrieved from that repository service **38**.

In any case, the Layer (1) Digital Black Box Recording does not have Protected Health Information (PHI), and if it is provided, it is stripped off and eliminated from the stored data. The possible PHI is removed from drivers handling specific medical devices.

Block Chain Signature Anti Tampering Protection

When the MDDS **8***b*, **28***b* transfers the complete time synchronized and location data set **17**, **37** to a centralized repository **18**, **38**, then as depicted in FIG. **5**, the past data set **19**, **39** is "signed" **41**, **42**, and the Signature **44** is produced **43**. The signature can be transferred **45** or stored to the external Block Chain Server Authority **46** to tamper proof the data collected and have an external safety check for data consistency.

Electronic Black Box Recording Data Diagrams for Various Medical Data and Medical Relevant Data Sources.

Different medical and medical relevant data types are recorded, including location and patient ID metadata, and time synchronized with medical device data as depicted in FIG. **6**. Continuous medical devices **59**, laboratory devices **72**, professional journaling and comments **82**, personal wearables and fitness trackers **90**, and video capture systems **98** store the non PHI (Protected Healthcare Information) only.

Continuous Medical Measurments **59**:

When patients **51** are connected with physical sensors and leads **52** to medical devices **53** that have the capability to export real or near real time data **54** to an MDDS **55**, the MDDS **55** will timestamp, location and metadata associate the data created **56** with a Digital Black Box Recorder dataset **59** consisting of different data sessions **57** and idle time **58**.

Laboratory Data **72**

Samples of blood or other patient relevant organic samples **61** are taken and temporary conserved **62** and transported **63** by healthcare professionals **64** then properly processed and electronically identified **65** by laboratory device **66**. The lab equipment should have the ability to export metadata such as POC or ID-collected and lab results in an electronic format **67** which is collected and processed by the MDDS **68**. The MDDS will timestamp, location, ID and metadata associate the data creating **69** a Digital Black Box Recorder dataset **72** consisting of different laboratory results **70**, metadata of patient identification codes and idle time **71**. Protected Healthcare Information is stripped off and assure the data to be deidentified matching a single universal identification code to be stored instead if not already provided.

Medical Journaling **82**

Every patient **51** consult, visit or opinion **73** between patient **51** and the medical professional **74** can be recorded or have notes taken **75** by third party software or systems **76** and directly exported or queried **77** from the MDDS **78** systems at the place of creation (near the patient current location). The MDDS will timestamp, location, ID and metadata associate the data, creating **79** a Digital Black Box Recorder dataset **82** consisting of various notes and documents, video and audio notes **80**, metadata of patient identification codes and idle time **81**. Protected Healthcare Information will be stripped off and assure the data is deidentified matching a single universal identification code to be stored instead.

Wearables and Fitness Trackers **90**

Patient **51** might have **83** various personal wearable devices operating with BLE (blue tooth low energy or similar technologies) **84** that can be periodically or constantly in communication **85** with a fixed or portable MDDS or personal phone MDDS app **86** that has been preprogramed with a BLE MAC address to receive and associate the medical devices with the patient. Like the continuous medical measuring **59** and the measure-result laboratory systems **72**, data sessions are defined **87** with metadata such as MAC, location and the receiving MDDS ID **88** and not-relevant data segments **89**.

Video and Medical Relevant Data **98**

All patient **51** relevant video or medical relevant ambiental data **92** can be recorded **93**, time and location synchronized by the MDDS **94** system. The MDDS will timestamp, location and metadata associate the video and/or ambient data creating **95** a Digital Black Box Recorder video or ambient dataset **98** consisting of different data session **96** and idle time **97**.

Second Layer of Medical Data Governance: Positive Patient Identification and Data Validation

FIG. **7** shows the process of association between the patient and the data collected, or to be collected **101**, **121**. An external process, software or system, associates a Patient Identification code to a location **102** or patient-to-patient Identification code **122**. An active healthcare professional, or someone that has been assigned to verify the patient data, patient location or patient identification, confirms the three key elements of the patient data triplets: patient identification and its code **134**, segment or segments of time the

OSSI Ex. 1016

patient was on location **135**, and patient data collected at that location **109**, **136** throughout the active process **103**, **123**.

Due to patient location recorded or provided by third party systems **102**, **104** and data and metadata collected **101**, **108**, a subsession defined by start **105** and stop time **107**, identified by a healthcare professional **106** or by third-party systems allows the precise selection of the appropriate and consistent data session **111** and seamlessly finetunes the accurate start **110** and stop **112** of the particular data session **113**, then creates the building block of triplets **132** that constitutes a complete positive patient identification and data validation record **130**.

For a laboratory, or multi patient systems such as laboratory machines, an action that immediately precedes or clearly relates to the result being consecutively transferred and collected by the MDDS system **121**, a previously created Patient Identification code **122** is collected as metadata and time synchronized with the result that is collected. An active process of confirming the data **128**, patient and patient id **125**, and validity of test result **123** creates the triplets **133** from the data set recorded **126** and the patient, time segment and location information **124**.

Protected Healthcare Information and Anti Tampering with Block Chain Signature

As depicted in FIG. **8**, the process of active Positive Patient Identification and Data Validation creates multiple patient time segment data records **132**, **133** associated with the patient **130** where PHI is shown, visible **131** and essential for positive patient association and the data validation process. After the modification of the previous data segments due to different information such as different times or location association, or upon creation of new triplets, they are stored **139** separately **145** from the storing **138** of the PHI **131**. PHI **131** is stored **138** on third party systems **140**, **141** running on a protected database system **142**.

Upon confirmation of the triplet's association **145**, each triplet is recorded **146** on a database **147** that triggers an automatic digital signature of each record **149** and a signature certificate is transferred **150**, **151** and delivered **152** to the third party Block Chain system **153** for safety and anti-tamper proofing of the data.

Medical Data Outputs and Deidentified Research Data Exports

The third layer of the Medical Data Governance System is data extraction and single point of truth for legacy and future healthcare data systems. As depicted in FIG. **9**, dependencies for adequate data outputs are defined as follows: the database **147** is populated with multiple **158** patient associated data session records **145**, and the different PHI data **157** are also recorded and protected from non-authorized use **142** and interfaced to the MDGS **160**. A Block Chain external service **153** is used to prevent data tampering and interfaced to the MDGS **162**. Real time data is available through secure proxy tunnel **148** from bedside MDDS systems **8***b*, **28***b*. Previous location and proper time reference, metadata drivers and medical device drivers are set and ready **101**. Drivers for barcode or POC inputs are properly installed to the MDDS system **8***b*, **28***b*, connected to laboratory, spot-like, multi patient medical systems **121**.

Patient ID is coded to barcode or POC patient code from third party systems and is available for research **122**. Patient locations are available from third party systems or documented **102**. Active healthcare professional(s) or an adequate automated system is assigned to verify and confirm patient id, location or barcode ID, time span, and to validate the collected data **123**, **103**.

True Source of Data and Data Export

As depicted in FIG. **9**, by concentrating all available medical relevant data into a single source designed to handle very large, different data formats (data, metadata, values, trending, waveforms, video etc.) and providing a subset of data to each receiving subsystem **173**, **176**, **179** with the correct source and time reference, the Medical Data Governance System becomes the True Source of Data and guarantees the data consistency through the use of block chain signatures.

Due to the exponential data availability from growing health related devices, the risk of data not being collected, or worst being wrongly associated grows exponentially. The Medical Data Governance System opposes this trend by using the same data to augment the data affinity and isolate and indicate a possible association or data integrity errors.

An MDGS **163** data export subsystem with specific, recorded and real time data in relation to location or to patient source can be configured **167**, **168**, **169** for output system **173**, **176**, **179**. Internal to a MDGS export data sub-item, a backbone of all data is available **166** for export drivers **167**, **168**, **169** access. For example, a minute-based representative value subset for a patient can be configured (exported to EMR, along with the triplets Unique Identifiers (IUD) for later more in-depth review **173**, **176**, **179** through a different export driver. Selected high frequency, high accuracy data can be exported, after a prolonged period like 30 or 60 days, to AI systems for machine learning processes **173**, **176**, **179**.

In essence, data export of the same complete data acquired from medical devices **167**, **168**, **169** can be different depending on the different requirements of exporting systems, and the export drivers and protocols **171**, **172**, **174**, **175**, **177**, **178** can be created on demand from original, complete, high frequency, high fidelity, rich data sets stored in Digital Black Box records, time synchronized and with positive patient identification and data validation.

In another aspect of the invention, hospitals and other healthcare facilities providing surgical services must coordinate a myriad of resources, medical personnel, and hospital staff to provide optimum and efficient care to their patients. Information about status of these resources and the facilities' patients must be updated constantly and be available to the relevant medical personnel and facility staff in the operating rooms (ORs) where the surgical services are delivered, in other ancillary rooms of the facility, and to medical personnel and facility staff who may be in remote locations.

In an embodiment of the invention, FIG. **10** is an example illustration of a daily schedule **208** for the operating rooms of a hospital or healthcare facility. Schedule **208** would be displayed on a multiplicity of digital whiteboards in various places of the healthcare facility such as the anterooms of the operating rooms. The rows of schedule **208** correspond to different operating rooms of the facility. For example, rows **210** and **212** correspond to OR 1 and OR 2 respectively as indicated. The columns, for example **214** and **216**, correspond to the time of use of the operating rooms by the patient cases undertaken. The current time of day is indicated by a vertical line **224** through schedule **208**.

The patient cases scheduled are depicted as shaded or colored blocks, for example **218** and **220**, extending for the length of time they will occupy the operating room. Text within the blocks, such as shown **218** and **220**, provide details of the cases such as the name of the patient and the procedure planned. The type of shading or different colors of the blocks **218** and **220** indicate the case status and current

location of the patient. Alerts concerning the case such as pertinent allergies may also be indicated by a separate shaded or colored area with a case block as illustrated at **222** for example. Such a color-coded, resource-focused schedule in combination with a display of simplified information is unique in the setting of a hospital or health-care facility and is surprisingly effective in providing a comprehensive picture of the data needed to optimally organize the doctors, nurses and other health care personnel, and the resources they need, and further, uniquely and surprisingly enhances the making of quick, accurate decisions in critical situations.

Surgical teams can be formed and assigned easily using a display **230** of individual health care facility personnel organized by specialty and work shifts such as illustrated in FIG. **11**. Medical personnel by specialty are shown at the display top **242**. In this example, the group of anesthesiologists have been selected to be displayed by highlighting tab **232**. Once selected, the anesthesiologist's names and pictures are displayed in a row as indicated **236**. Alternatively, if any of tabs **234** were selected and thus highlighted, the corresponding group of medical personnel would be displayed at the top **242**.

To form a particular team, individual personnel available to work that day are dragged and dropped to the appropriate position in the chosen team in lower box **240**. As an example, in FIG. **11**, Dr. H has been dragged and dropped on the MD position on OR 2 (numbered **244**) as indicated by arrow **238**. In some instances, personnel can be assigned to more than one teams. In such a case, the picture and name of the person remains in the top row until he has been assigned the maximum number of times. This is shown by example with the photo of Dr. H remaining in the top row **236** at the same time his photo is displayed as a part of OR 2 (numbered **244**). The maximum number of times a person can be assigned to a team is typically determined on an individual basis.

Once formed, the teams are dragged and dropped on particular patient cases and then displayed on the main schedule **208** on whiteboards and other displays throughout the facility. The dragging and dropping process can be carried out directly on the whiteboard or other display using a method of digital input such as computer mouse or stylus, or to facilitate quick and easy input to the display on a digital whiteboard, a user can use for example a tablet computer communicating with the whiteboard via a bluetooth or other wireless connection and displaying a facsimile of the team building screen.

A suitable digital whiteboard capable of displaying the schedule **208** is the Hitachi Starboard FXTRIO Interactive Whiteboard available from Hitachi Solutions America, Ltd., 601 Gateway Blvd. Suite 100, South San Francisco, Calif., although many other digital whiteboards or other computer-controlled display systems can be used. If the Starboard FXTRIO digital whiteboard is used, then a software interface such StarBoard Software also available from Hitachi Solutions can be used to facilitate the creation and modifications of schedule **208**.

FIG. **12** is a block diagram overview of the overall system running the ORMS software in an embodiment. Local server **250** receives, stores, calculates, and transmits data in forms such as schedule **208** to the facility operating room sites **252** and facility offices and stations **254**. Schedule **208** and other data may be displayed on for example digital whiteboards, desktop displays, tablet computers, or mobile devices depending on the needs of the site or office. The local server **250** is in continual, real time communication with cloud-based server **256** which is not physically located at the healthcare facility. In an alternative embodiment, all variable patient, case and resource data is maintained on the local and cloud-based servers and downloaded to the individual whiteboards, displays, stations, or departments, but calculation and formatting of the schedule and determination of alerts is done by applications or software modules running on the PC's or embedded computers associated with each individual whiteboard, display, station, or department.

All substantive data on local server **250** is continually backed up on cloud-based server **256** and vice versa as indicated by arrow **258**. In this embodiment, the data continually backed up includes all current information about the patient cases the hospital has undertaken and the information about the health care facility resources and personnel necessary to calculate and display the schedule.

Cloud-based server **256** transmits a facsimile of the schedule **208** and other data to apps on the mobile phones **260** of doctors and other relevant health care personnel. Also, via this path, alerts can be texted or otherwise transmitted to specific personnel. An alert is short message or datum of high importance and urgency. Alerts may for example indicate an unexpected problem or delay with a particular patient or case, or patient overcrowding at a particular stage or location within the facility. Alerts can be manually triggered for example by personnel at any of the offices and stations **254**, or automatically triggered by one of the servers based on calculations from data input by personnel at for example operating room sites **252** or offices and stations **254**. Such automatically triggered alerts can be fixed as a part of the system design or can be customized by various healthcare facility personnel.

An alert displayed on one or more mobiles phone **260** can be responded to immediately by a user or users and data in the response displayed in real time on one or more of the digital white boards near the OR's **252**, station or office desktop displays **254** or other displays in the healthcare facility or in the overall system. The response can be a direct change in the displayed schedule or used to automatically calculate a change in the schedule which is then displayed. Personnel at these sites can then make further adjustments to the schedule or input other data accordingly. Correspondingly, any changes in the schedule such as illustrated FIG. **10** will be transmitted in real time to the other sites and the apps on the mobile phones **260**. Having the capability of alerts for mobile users which can be responded to by transmitting schedule changes to the overall system is a unique and surprisingly effective method of optimizing the resource usage of the hospital or health-care facility.

Local server **250** can be implemented using a standard PC with for example an Intel Ivy Bridge microprocessor running the Windows 7 operating system. Of course Apple or UNIX-based computers, among others, could also be used as would be obvious to engineers with ordinary skill in the art. Cloud-based server **256** can be implemented for example using a commercial cloud computing service such as Amazon Web Services available at URL http://aws.amazon.com/ or using standard PCs at a remote location. Software development for the servers and the station or desktop modules can be done in Visual Basic with the Microsoft Visual Studio development environment although myriad other programming languages and development environments can be used. The displays such as illustrated in FIGS. **10** and **11** are typically implemented using an internet browser such as Firefox and coded in HTML although other browsers or direct implementation in Visual Basic or many other pro-

gramming languages and development environments known to software engineers with ordinary skill in the art can be used.

FIG. **13** is a block diagram of an arrangement of application-specific servers at remote cloud server **262** in another embodiment of the invention. In this embodiment, cloud server **262** includes a mobile applications server **264** which communicates directly with the mobile phones of users running an app **266**. The mobile applications server can also send and receive SMS text messages to the mobile phones **268** of users whose phones do not have the mobile app capability.

Cloud server **262** also runs the digital white board application server **270**. Both the digital white board server **270** and the mobile applications server **264** communicate data directly to the analytics and report engine server **272** which analyzes said data and creates appropriate reports. Said reports are sent periodically via the report scheduler **278** to the appropriate personnel, collectively **274**, at the hospital. Generally, realtime data is communicated to and from the hospital display locations, stations, departments, and offices via the hospital web server **276**.

FIG. **14** is a block diagram showing patient movement through the health-care facility. In this embodiment, when a patient enters the reception area **282**, his arrival is input to the hospital web server **280** by admitting personnel and his case is displayed on the OR schedule such as illustrated **218** and **220** for example on FIG. **10**. As the time for the patient's operation approaches, he moves to SDS **284** and then to the OR holding area **286**.

At each department or station, the patient's progress is updated on the OR schedule by the staffing personnel who typically input the data using desktop PCs or tablet computers. The ORMS software module running on the desktops PCs or tablet computers is typically customized for each department or station.

At the appropriate time and when the surgical team and all resources are ready, the patient moves to the OR **288** and the operation is performed by the surgical team. After the operation is complete, the patient moves to the PACU **290** and when ready the discharge area **292** where the patient may fill out a survey which he inputs directly to the hospital web server **280**.

In another embodiment, FIGS. **15** to **18** illustrate dockable slide-out panels on the OR schedule. In FIG. **15**, Tabs **300**, **308**, **310**, and **312** arrayed on the right hand side of the daily schedule display **96** have labels indicating available panels with pertinent information. Other such tabs, as indicated at **304**, are arrayed on left hand side of schedule **296**. In FIG. **16**, the Alerts tab **308** has been selected using for example, a computer mouse or touch screen entry, and the alert panel is displayed **302** while Alerts tab **308** temporarily disappears.

Information or notes can be added directly to panel **302** with digital input, for example, keyboard or computer mouse, and this information or notes is reproduced on some or all schedule displays through the hospital depending on user-selectable parameters. In an alternative embodiment, information or notes can be written directly in panel **302** area in an analog manner, that is, with a stylus or even a finger, and this information or notes is reproduced on some or all schedule displays throughout depending upon selectable parameters.

FIG. **17** is an illustration of the schedule **96** when the Addons tab **310** has been selected such that the Addons panel **297** is displayed. An addon is a case which is newly added after the schedule for the day is created, with corresponding allocation of the hospital personnel and resources, and which is expected to run past a hospital's employee shift change time. Another type of addon is a case which was on the daily schedule when created but is delayed or running late due to unforeseen circumstances and is thus expected to run past the time of one or more employee shift changes. It is important for hospital managers and administrators to know quickly and accurately how many addon cases they have and through what shift changes they will go so they can make sure they will have the personnel present and resources on hand to cover these cases. A hospital or other health-care facility may have several shift change times when nurses, technicians, and other medical and administrative personnel end or start their work day. For example, a hospital might generally have four shift change times at 3:00 PM, 3:30 PM, 5:00 PM, and 7:00 PM.

For example, in FIG. **17**, block **314** is highlighted to indicate there is one or more addon cases in OR 1. Block **116** is highlighted to indicate there is one or more addon cases in OR 4. And block **318** is highlighted to indicate there is one or more cases in OR 7. When no addon cases have been added to the schedule for an operating room, the corresponding addon block is not highlighted, for example, **315**, and remains the neutral color of the schedule, typically white.

The highlighted addon blocks, **314**, **316**, and **318**, contain a simple symbolic code, such as seen at **320** for example, which indicates how many addon cases are scheduled for the corresponding OR and the shift change times they are expected to run past. In this embodiment, the symbol **1** is used in the code to indicate an addon case that will run past a shift change. The position of the symbol **1** in the code indicates which shift change the addon case will run past. So in the case of a hospital with four employee shift changes at 3:00 PM, 3:30 PM, 5:00 PM, and 7:00 PM such as described hereinabove, the code would have up to four positions, reading from left to right. So for example, the code **320** has a 1 in first position indicating a case which will run past the earliest shift change time of concern, 3:00 PM. Then there is the symbol '/' as a separator and then the symbol 0 as a placeholder, indicating that there are no addon cases in OR 7 anticipated to run past the 3:30 PM shift change. Continuing to read from left to right at **320**, there is a second '/' and then a 1 indicating that there is an addon case expected to run past the 5:00 PM shift change time. Finally, there is a '/' and a 1 indicating that there is an addon case expected to run past the 7:00 PM shift change. Note, it may or may not be that the addon case running past the 7:00 PM shift change is the same case or a continuation of the same case that is expected to run past the 5:00 PM shift change as described hereinabove.

Thus, the combination of color highlighting **314**, **316**, and **318**, and a simple symbolic code **320**, enables a hospital administrator or medical personnel manager to at a glance quickly and accurately determine the additional personnel and resources needed to timely complete, with optimum outcome, the cases the hospital has undertaken. That this combination of color highlighting and an associated simple symbolic code on a comprehensive, real-time updated daily schedule displayed or available to display at a multiplicity of locations throughout the hospital or healthcare facility, provides such facile comprehension of a possibly critical situation at hand, permitting quick and accurate decision making by perhaps a multiplicity of hospital or health-care facility administrators and managers at different locations, is a unique and surprising, perhaps even revolutionary, result.

FIG. **18** is an illustration of the schedule **296** when the Breaks tab **312** has been selected such that the Breaks panel

306 is displayed. A break is a relatively short period during the work shift of a hospital or healthcare facility employee when they are "off-duty", perhaps having a meal or a rest-break. The current break status of an employee is displayed and can be modified in the Breaks panel **306**.

The personnel on a particular OR team are displayed in the row corresponding to the OR to which they are assigned such as indicated at **323**. The name of team member not on break and working normally, indicated at **320** for example, will have a background of a neutral color, typically the same as the neutral color of daily schedule, typically white. A team member name can be selected, such as by clicking with a computer mouse or tapping with a finger or stylus on a touch-sensitive display, and then the background of the team member name will turn a color, for example **322**, understood to indicate they are on break. A team member name can be selected a second time, and the background of their name will turn a second color, for example **324**, understood to mean they have returned from break and are now working normally. After a set period, perhaps a few minutes, which can be configured by hospital administrators or other personnel, the second colored background **324** will automatically change back to the original neutral color indicating normal working status **320**.

The organizational efficiency and decision making confidence gained by having all this information about the hospital's current patient cases available in a single view display of the daily schedule of the hospital is unique and surprising. However, while the hospital administrators, like the hospital medical personnel, benefit from having available comprehensive information about the hospitals current cases and relevant resources, not every administrator needs to have a continuous view of the schedule display.

FIGS. **19** and **20** are illustrations of a stoplight icon **330** which can be displayed on the computer desktop display **338** of administrators and at stations where the OR schedule display is not continuously needed. In a fashion similar to the workings of an ordinary traffic light for the control of street traffic, when there are no known problems likely to interfere with hospital's daily schedule as planned, the upper "lights" **332** and **334** would be dimmed and lower "light" **336** would be highlighted, typically green. If an alert condition occurs, which can be manually triggered or automatically triggered by calculation as described hereinabove, then light **336** would be dimmed and upper lights **334** or **332** typically would be yellow or red respectively, depending on the urgency of the alert.

As shown in FIG. **20** stop light icon **342** would typically be shown in a small window **340** on an administrator's PC desktop **338** but in other embodiments the icon could stand alone on the desktop without a surrounding window or in many other configurations as would be apparent to software engineers of ordinary skill in the art.

FIG. **21** is an illustration of the main navigation screen of the ORMS app on the smartphone **350** of a user who might typically be a doctor or nurse at the hospital. The smartphone display indicated **352** shows selectable options to display the user's personal schedule **354**, the OR daily schedule **356**, the staff directory **358**, the user's messages **360**, and the user's account settings **362**.

In another embodiment of the invention, a customized active cable arrangement is provided having at one end, a connector designed to mate with a specific medical device which transmits digital data that may be in a proprietary format, through said connector. At its other end, said cable arrangement is provided with a second connector, typically of a standard type, such as USB, PoE (Power Over Ethernet) for connecting with a supporting standard monitor for display.

FIG. **22** is a block diagram overview of an embodiment of the customized active cable arrangement. According to the invention, medical devices **404**, **405** and **406** are connected using corresponding active cable arrangements **401**, **402**, and **403** to a conventional medical display monitor **407**. Note that the term "active cable arrangement" and "active cable" are used herein to describe the programmable dongle **412** and associated connectors and cables as will be explained in more detail below. In the example shown, medical devices **404**, **405**, or **406** can take on many different forms. Example medical devices include patient monitoring devices, blood analyzers, infusion pumps, ventilators, mobile EKG units, glucose analyzers, incubators, or other devices. Typically, "legacy" or third party medical devices lack an ability to be seamlessly integrated with a health care or hospital information system. The medical devices **404**, **405**, and **406** may have proprietary connectors (i.e., output ports having a non-standard physical arrangement) and/or transmit data in a proprietary format. In accordance with one aspect of the invention, the active cables **401**, **402**, and **403** of the invention are custom manufactured to order, both physically (if necessary) and with respect to the logic with which they are preprogrammed, for each corresponding medical device **404**, **405**, or **406**. Thus, the user has the sensation of "plug and play" by simply connecting the medical device **404**, **405**, or **406** to an active cable **401**, **402**, or **403** of the invention to a conventional monitor USB port or USB hub extending the monitor USB port. The active dongle **412** of the invention is programmed to transform the proprietary data transmission protocol of the medical device **404**, **405**, or **406** and provide the monitor **407** (or other device) with standardized output for data, waveforms, alarms, setting, notifications, values and other useful information.

Instead of the general purpose processing capability of the usual intermediary PC or other intermediary electronic device, the active dongle **412** of the active cable arrangement of the invention has a dedicated, preprogrammed processing capability for transforming the data to a standard format for storage and display. The active dongle **412** is not easily susceptible to reprogramming or hacking. It is not expected that a software update would ever be required during the normal lifetime of the associated medical device as the data transmission protocol of the medical device **404**, **405**, or **406** will never change.

If a new medical device is added or replaces an older device, it is not necessary to install a new software driver on an intermediate PC (or equivalent), an uncertain prospect depending on the PC operating system, compatibility with other drivers/devices and many other details. Instead, along with placing into service a new medical device, a new active cable arrangement according to the invention is ordered and simply plugged in.

The supporting monitor **407** should support the display of the standardized and known, well documented values for data, waveforms, alarms, setting, notifications, values and other useful information from the USB dongle **412** of the invention, for example the software API and specifications of the normalized JSON protocol.

Prior to the invention, such medical devices **404**, **405**, or **406** would typically transmit data to an intermediary general purpose computer, for example, a conventional PC, for processing including display, analysis and recording. Such general purpose computers are commonplace and nominally

inexpensive. But such PCs require continual maintenance including security and function upgrades. In well publicized incidents, computer hackers have halted or impeded the operations of health facilities, hospitals or entire health systems as a result of such intermediary PCs not having security upgrades implemented.

FIG. **23** illustrates the same-glass, side-by-side (or vertically arranged) synchronized display of the data transmitted by medical devices **404**, **405** and **406**. It should be noted here that the data transmitted by the medical devices **404**, **405**, and **406** will be displayed simultaneously on the monitor **7** in real time, even though the devices will be plugged into separate inputs. Preferably, monitor **7** is a standard medical monitor utilizing the JSON protocol. In an embodiment, connecting cables **10** do not have customized processing capability although they are equipped with conventional or proprietary connectors suitable for corresponding connected devices **404**, **405**, and **406**. Instead, cables **410** plug into USB dongles **412** to form the cable arrangements **401**, **402**, and **403** of the invention, with each having customized processing capability corresponding to each connected medical device. USB dongles **412** in turn plug into conventional medical monitor **407**. USB dongles **412** process the data from corresponding connected medical devices **404**, **405** and **406**, synchronizing it and formatting it for display **408** on monitor **407**. The use of USB to connect to the dongle **412** to monitors is advantageous because it provides power to the dongle **412**.

The active dongle **412** and associated connecting cables are built from standard parts by the manufacturer for the ordered medical device. Building the active cable assemblies **401**, **402**, or **403** from parts involves selecting the right connector and protocol for the device **404**, **405**, or **406**, which protocol is written to the dongle **412** in a manner well known to those of skill in the art and then assembled and shipped to the user. The manufacturer does not need a skilled workforce.

An intermediary IoT Connectivity Device **409** is used to facilitate recording in an embodiment illustrated in FIG. **24**. An IoT Connectivity Device is a hardware device that enables physical and logical data transformation from proprietary and non-standardized protocols, to be collected and transformed into a standardized dataset. It also serves as a security and functional layer around the medical devices. As it has all the protocols implemented locally, it does not suffer from data loss (i.e., does not need to be reprogrammed or booted up) if the network is temporarily or otherwise unavailable. It is equipped with a battery and can be unplugged for significant periods, such as during transfer, or unforeseen power outages such as accidental connector detachment or temporary power failure, with full operational readiness. An IoT device used in the medical environment must be compliant with regulations imposed by law (for example with IEC EN 60601-1). TCP and UDP protocols and ports are used.

Ordinary cables **422**, **423** and **424** connect medical devices such as **404**, and for the purposes of FIG. **24** only, **402** and **403**, to device **409**. The device **409** formats the data for recording and uses Network API **19** to transmit the data to Hospital Information System **420**. One should appreciate that the hospital information system **420** has a number of roles or responsibilities with respect to medical devices. One responsibility of the hospital information system **420** includes coordinating or managing activities of medical devices. The data formatted for display is then transmitted to conventional monitor **407** for display **408** via cable arrangement **401**, **402**, or **403** with optional USB dongle **412**.

For example, in a hospital operating room (OR) during a typical 24 hours, patient monitors, anesthesia machines or ventilators, EEG monitoring, a BIS monitor and a few IV pumps will typically create 1 GB of data with perhaps a 60-85% compression ratio, resulting in a 150-400 MB encrypted repository for complete, high frequency datasets, including waveforms.

For an average ten hours of OR usage per day, and twenty four Hours ICU Monitor per patient, the twenty four hours encrypted, and compressed storage are expected to be in 80-120 MB range per bedside location.

FIG. **25** is a block diagram illustrating the physical construction of the active cable arrangement of the invention in an embodiment. The active cables **401**, **402**, or **403** are manufactured to order for a specific, medical device such as **404**, **405** or **406**. Connector **411** may be standard or proprietary, specific to said device **404**, **405**, or **406**. Connector **411** plugs into or otherwise connects to a standard RJ45 connector **413** which terminates both ends of a standard Cat 5 or Cat 6 Ethernet cable **410**. The connector **413** opposite from said medical device **404**, **405**, or **406** plugs into USB dongle **412** which contains the processing capability and customized preprogrammed logic necessary to format for synchronized display data from said medical device. USB dongle **412** is powered by standard electrical output from the monitor **407** to which it is connected.

FIG. **26** is a block diagram illustrating the logical construction of the USB dongle **412** in an embodiment. Processor **427** receives power through USB standard connector **417** by which, dongle **412** is plugged into a monitor. Processing unit **429** receives data via medical device connector **431**, converts proprietary data format to JSON key-value pairs, communicates using this standard format over bus **428** to processor **427** which synchronizes the data and otherwise prepares it for recording and display. As mentioned above, monitor **407** is a standard medical monitor and will automatically display the reformatted data from medical devices **404**, **405**, or **406** as standalone or in a combined time synchronized manner. The data from medical devices **404**, **405**, or **406** is not just displayable on monitor **407**, it is transformed so as to be useable for any device. For example, data from device **404**, **405**, or **406** may be transmitted to hospital information center **420**.

FIG. **27** is a block diagram illustrating the cable arrangement and overall system in an embodiment. USB dongle **412** is connected to medical device **404** via a cable constructed as described in the description associated with FIG. **25** hereinabove. Dongle **412**, a programmable microprocessor driven interface device, communicates with device **404** via proprietary protocol **426**, uses its preprogramed logic to process the data into a standard format, and then transmits the processed data to monitor **407** using a standard protocol **428**.

In another embodiment, the invention provides an automated method for providing a connecting cable arrangement **401**, **402**, or **403** for connecting a legacy or third party medical device such as **404**, **405**, or **406** having a proprietary connection arrangement or data transmission protocol (or both) to a standard medical monitor, from a manufacturer to an end user. In a preferred embodiment the method is implemented by way of a secure internet transaction. FIG. **28** shows a diagram representing principal equipment and key actions involved in a common internet purchasing transaction. A customer computing device **440** such as a PC, smart phone, tablet, or other device is operated by a user (not illustrated), for example, a person using his or her home or office computer. The customer has internet access via WiFi,

or equivalent allowing the customer to communicate over the internet **444** to a large number of web sites. The customer accesses web sites of interest using the computing device **440**. One web site is represented by a manufacturer **446** of the inventive active cable arrangement, the web site having data processing equipment including a server **448** for processing and saving data. Server **448** includes a database of known legacy medical devices. In accordance with the method, the end user would select a device of interest from a "drop down" list, a list of representative GUIs, or other means of displaying identifying information representing a list of medical devices/products stored on server **448**. For each medical device listed, its transmission protocol and connection arrangement is known and stored on the server **448** but transparent to the user. The list is generated by the server **448** and can be transmitted over the internet **444** to the user for display on the user device **440** in response to a user request. If the user sees the desired medical device on the list he/she simply "clicks" on the device displayed on the list. Preferably, an actual image of the device (with the physical arrangement of the device output connector apparent) is stored on the server **448** and displayed in response to the click and the user can verify that the model selected is indeed the desired model. The user may then complete the transaction in the well known manner. Using the saved data regarding the selected device on server **448**, which saved data will include the particular transmission protocol as well as the details of the particular connection arrangement of the selected legacy medical device, the manufacturer **446** will then provide or fabricate all of the cables and connectors necessary as discussed above, and program the dongle **412** with the appropriate software to generate an active cable arrangement such as **401**, **402**, or **403**. The arrangement is then shipped to the user, who can then connect the medical device **404**, **405**, or **406** to the monitor **407** in "plug and play" fashion. The user need not further configure or program the cable arrangement or monitor **407**.

If the user's desired medical device **404**, **405**, or **406** is not saved in the server **448** database, the user would provide either a specific model number and/or other information necessary for the manufacturer to determine the physical characteristics of the medical device connector as well as the data transmission protocol of the device. It should be noted that the above method is not limited to the examples shown, but can be used to retrofit any legacy or non-standard device for connectivity.

The invention could be used not only for display devices, but in general for any device, regulated medical devices as well, to receive standardized medical data from supported medical devices, if latter is equipped with standard USB connectivity and ability to read a standard protocol provided.

Although particular embodiments have been described in this disclosure, many other variations and modifications will be apparent to those skilled in the art. Thus, the instant invention can be defined and limited only by the claims to be associated with this application.

The invention claimed is:

1. A system for managing the display of a real time daily schedule, said schedule displayed in real time on a first type of display in operating rooms of a healthcare facility in a building and a second type of display on mobile phones, the system comprising:

at least one server running a program having a set of data concerning the management of said operating rooms and being capable of displaying, on both said first and second display types; a real time daily schedule;

a software interface for receiving and configuring the display of said real time daily schedule on said first display type;

said schedule as displayed on said first display type comprises at least one block displaying an image having first, second, and third colored portions, said software interface selectively highlighting said first colored portion and dimming said second and third colored portions in response to a first scheduling scenario, said software interface highlighting either said second or third colored portions in response to an alert condition.

2. The system for managing the display of a real time daily schedule according to claim **1** wherein said server is further capable of communicating with at least one mobile phone which runs an application capable of alerting a mobile phone user.

3. The system for managing the display of a real time daily schedule according to claim **2** wherein the display by said application is of the daily schedule of the user.

4. The system according to claim **1** wherein said first display type in operating rooms are whiteboards, said whiteboards capable of receiving and displaying data which is input digitally to said whiteboards using a tablet computer and said whiteboards are further capable of receiving and displaying data which is input in an analog manner directly on the surface of the whiteboard.

5. The system according to claim **1** wherein the first display type in operating rooms of a healthcare facility in a building and the displays on mobile phones are capable of displaying a schedule for teams of healthcare facility personnel, said teams having been formed from a displayed list of healthcare facility personnel.

6. The system according to claim **2** wherein specific data input to said server will automatically trigger the sending of an alert to said user.

7. The system according to claim **2** wherein specific data input to said server will automatically trigger the texting of an alert to a user having a mobile phone.

8. A system for managing the operating rooms of a healthcare facility in a building, comprising:

a cloud server running a program having a set of data concerning the management of said operating rooms and being capable of displaying a real time daily schedule for said operating rooms in said building, said cloud server including a mobile application server for receiving and transmitting said schedule as well as reports to mobile devices, said mobile devices having a first display type, said schedule and said reports based on real time analysis of said data;

a hospital web server also receiving said schedule and reports from said cloud server;

a software interface for receiving said schedule and reports from said hospital web server and configuring display of said schedule and said reports for a second display type;

said schedule as displayed on said first display type comprises at least one block displaying an image having first, second, and third colored portions, said software interface selectively highlighting said first colored portion and dimming said second and third colored portions in response to a first scheduling scenario, said software interface highlighting either said second or third colored portions in response to an alert condition.

9. A system for managing the operating rooms of a healthcare facility according to claim **8** wherein said mobile

application server is further capable of communicating with at least one mobile phone which runs an application capable of displaying said real time schedule and alerting a mobile phone user on said first display type.

10. A system for managing the operating rooms of a healthcare facility according to claim **9** wherein the display by said application on said second display type is of a daily schedule of the user.

11. A system according to claim **8** wherein said second display types are whiteboards in operating rooms , said whiteboards capable of receiving and displaying data which is input digitally to said whiteboards using a tablet computer and said whiteboards are further capable of receiving and displaying data which is input in an analog manner directly on the surface of the whiteboard.

12. A system according to claim **9** wherein the first and second display types are capable of displaying a schedule for teams of healthcare facility personnel, said teams having been formed from a displayed list of healthcare facility personnel.

13. A system according to claim **9** wherein specific data input to said server will automatically trigger the sending of an alert to said user.

14. A system according to claim **9** wherein specific data input to said server will automatically trigger the texting of an alert to a user having a mobile phone.

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