(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 June 2017 (29.06.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/108996 A1

(51) International Patent Classification:
A61B 5/00 (2006.01) *H04W 40/00* (2009.01)
G08C 25/00 (2006.01) *H04W 52/00* (2009.01)
A61B 5/0205 (2006.01) *H04W 84/00* (2009.01)
H04L 1/08 (2006.01)

(21) International Application Number: PCT/EP2016/082247

(22) International Filing Date: 21 December 2016 (21.12.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/270902 22 December 2015 (22.12.2015) US

(71) Applicant: KONINKLIJKE PHILIPS N.V. [NL/NL]; High Tech Campus 5, 5656 AE Eindhoven (NL).

(72) Inventors: WANG, Dong; High Tech Campus 5, 5656 AE Eindhoven (NL). ESPINA PEREZ, Javier; High Tech Campus 5, 5656 AE Eindhoven (NL).

(74) Agents: VAN IERSEL, Hannie, Cornelia, Patricia, Maria et al.; Philips International B.V. – Intellectual Property & Standards, High Tech Campus 5, 5656 AE Eindhoven (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: LOW-POWER WIRELESS SOLUTION FOR MBAN APPLICATIONS WITH MULTIPLE AGGREGATOR DEVICES

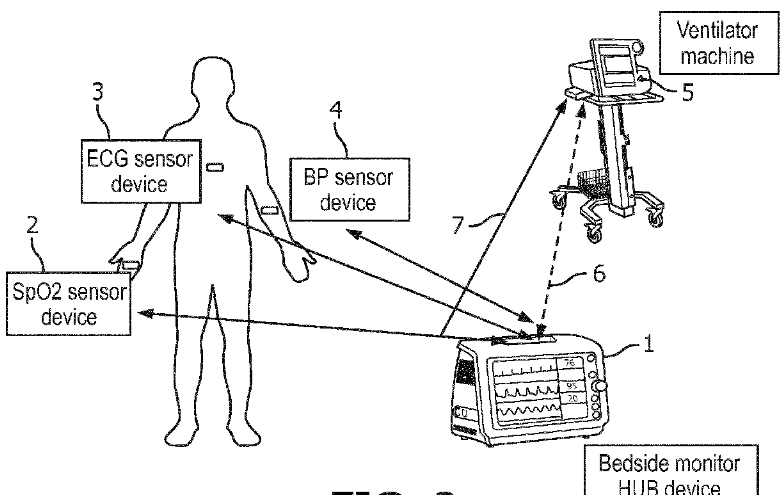

FIG. 2

(57) **Abstract**: 2015PF01643 23 ABSTRACT: A Medical Body Area Network (MBAN) (10) includes a hub device (18) with a wireless communication transceiver (34). One or more sensor devices (14) each include a physiological sensor (24) for acquiring physiological data and a wireless communication transceiver (22) configured to connect with the wireless communication transceiver (34) of the hub device (18) to wirelessly transmit acquired physiological data to the hub device (18). One or more aggregator devices (16) each include a wireless communication transceiver (30) for receiving physiological data acquired by the one or more sensor devices (14). The hub device (18) is configured to respond to not wirelessly receiving a missing data portion of physiological data acquired by a sensor device (14) by requesting and receiving the missing data portion from an aggregator device (16).

WO 2017/108996 A1

LOW-POWER WIRELESS SOLUTION FOR MBAN APPLICATIONS WITH MULTIPLE AGGREGATOR DEVICES

FIELD

The following relates generally to wireless communication. It finds particular application in conjunction with medical body area networks (MBANs), and will be described with particular reference thereto. However, it is to be understood that it also finds application in other usage scenarios and is not necessarily limited to the aforementioned application.

BACKGROUND

There is a general trend in the healthcare industry towards ubiquitous patient monitoring, which is to provide continuous and patient centric monitoring services during the whole care cycle. Such ubiquitous monitoring services can significantly improve quality of care. For example, patient deterioration could be detected at an early stage and early intervention can effectively prevent severe adverse events to happen.

The advance of wireless communication technologies makes such ubiquitous monitoring feasible. The medical body area network (MBAN) technique has been considered as one of the promising solutions to achieve ubiquitous monitoring. A medical body area network (MBAN) replaces the tangle of cables tethering hospital patients to their bedside monitoring units with wireless connections. MBAN is a low-power wireless network of sensors around/on a patient used for monitoring patient's physiological data.

FIGURE 1 shows a typical MBAN system. In such MBAN system, several (typically miniature) sensor devices are placed on patient body to capture patient's physiological data, such as heart rate and electrocardiograph (ECG) waveforms, and the captured data is forwarded to a hub device through a short-range and low-power MBAN. The hub device may be a local bedside monitoring unit, cell phone, set-top-box, or other device with wireless connection to the MBAN sensors, and usually has a wired or wireless network connection to a backhaul network (e.g. a third/fourth generation (3G/4G) cellular network, LAN, PAN, WiFi, or the like), through which the collected data can be further transferred to a remote patient monitoring (PM) server. The remote patient monitoring server is responsible for analyzing patient's physiological data and providing monitoring, diagnosing or treating services in real time. (The hub may also provide such analysis functionality if it is a patient monitor or the like). Such wireless MBAN patient monitoring system provides a low-cost solution to extend patient monitoring services to the areas that are currently not monitored (e.g. general wards, patient homes, and the like) and allows patients to walk around in the hospital/at home without discontinuing monitoring services. This makes it possible to discharge a patient earlier from an Intensive Care Unit (ICU) or hospital, but still provide high quality care monitoring services at patient's home and this can reduce healthcare costs significantly.

To facilitate MBAN deployment, the United States Federal Communications Commission (FCC) has recently allocated a dedicated MBAN band ranging from 2360 megahertz (MHz) to 2400 MHz for MBAN services. In Europe, the European Conference of Postal and Telecommunications Administrations (CEPT) and the Electronic Communications Committee (ECC) has designated a dedicated MBAN band ranging from 2483.5 MHz to 2500 MHz for MBAN services. These bands are cleaner than the 2.4 gigahertz (GHz) industrial, scientific and medical (ISM) band, which is currently used by most wireless patient monitoring devices and many other types of wireless devices. Hence, the contemplated MBAN bands are useful for enhancing link robustness and providing medical-grade quality-of-service (QoS) in MBANs. Moreover, these bands are adjacent to the 2.4 GHz ISM band, which makes it possible to reuse low-cost, mature 2.4 GHz ISM band radios for MBAN services. Such radios include radios designed from the Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 standard.

The present application provides a new and improved system and method which overcome the above-referenced problems and others.

SUMMARY

Two major technical challenges that the MBAN design is facing are reducing sensor device power consumption (i.e. increasing their battery lives) and achieving medical-grade communication link robustness. A typical MBAN design includes a hub device and one or more sensor devices. In such a setup, each sensor just communicates with the hub and the hub is the only device that aggregates the sensor data, and there is no differentiation between sensor devices in terms of their battery/power capacities.

The hub is usually an a.c. powered device, so that battery life is not an issue. Even if the hub is battery-powered, it is usually a unit as compared with the typically miniaturized on-body MBAN sensors, and hence the battery life of the hub in such a case is long. It is recognized herein, however, that the MBAN may include other devices that are either a.c. powered or are larger devices with large batteries. For example, a mechanical ventilator machine may be included in the MBAN network, so as to supply to the hub (e.g. a patient monitor) patient data such as airway flow and pressure via the MBAN. The ventilator may also monitor or utilize data from one or more physiological sensors of the MBAN, such as an ECG. Conventionally, the ventilator would receive the ECG data indirectly via the hub.

It is recognized herein, however, that such devices are well-placed to provide data aggregation support for the hub. They are a.c. powered (or at least have large batteries), include the radio hardware for short-range MBAN communication which is prerequisite for joining the MBAN, and in some cases indirectly collect physiological data from the hub.

Thus, in embodiments disclosed herein, such a device serves as an aggregator device providing support for the hub. The short range wireless communication of the aggregator device (e.g., the ventilator) is used to directly collect sensor data that is already broadcast by the miniaturized sensors (albeit with the hub being the intended target). This data may optionally be used at the aggregator. Additionally, if the hub misses some sensor data it can request and receive that data from the aggregator device (e.g. from the ventilator). This improves robustness of the MBAN communication and reduces battery draw on the miniaturized sensor that would otherwise need to re-transmit the sensor data that was missed by the hub.

In accordance with one aspect, a Medical Body Area Network (MBAN) includes a hub device with a wireless communication transceiver. One or more sensor devices each include a physiological sensor for acquiring physiological data and a wireless communication transceiver configured to connect with the wireless communication transceiver of the hub device to wirelessly transmit acquired physiological data to the hub device. One or more aggregator devices each include a wireless communication transceiver for receiving physiological data acquired by the one or more sensor devices. The hub device is configured to respond to not wirelessly receiving a missing data portion of physiological data acquired by a sensor device by requesting and receiving the missing data portion from an aggregator device.

In accordance with another aspect, a non-transitory computer readable medium storing instructions executable by a hub device includes at least one microprocessor to perform a method for monitoring a patient using a Medical Body Area Network (MBAN). The method includes: at a hub device of the MBAN, maintaining a data types list of each type of data collected by at least one sensor device of the MBAN and an aggregator list of at least one aggregator device of the MBAN that is currently receiving one or more types of sensor data from the at least one sensor device; and, at the hub device, wirelessly receiving data from the at least one sensor device and, in response to not wirelessly receiving a missing data portion from the at least one sensor device, first requesting and receiving the missing data portion from an aggregator device listed on the aggregator list of the hub device as receiving the data type of the missing data portion and in response to not wirelessly receiving a missing data portion from the aggregator device, receiving the missing data portion from the source sensor device.

In accordance with another aspect, a Medical Body Area Network (MBAN) system for transmitting patient data is provided. The system includes at least one sensor device each including a physiological sensor for acquiring physiological data and a wireless communication transceiver. At least one aggregator device each includes a wireless communication transceiver for receiving physiological data acquired by the at least one sensor device. A hub device includes a wireless communication transceiver configured to connect with the wireless communication transceiver of the at least one sensor device to wirelessly transmit acquired physiological data to the hub device. The hub device includes at least one processor programmed to: receive a request from the at least one aggregator device to join the MBAN that the hub device is associated with; check the types of sensor data that the at least one aggregator device wants to receive; determine if the at least one aggregator device is willing to help the at least one sensor device perform retransmission when data loss happens between transmissions between the at least one sensor device and the hub device; notify the at least one aggregator device of the types of sensor data for which the aggregator device is responsible for retransmission to the hub device; receive data from the at least one aggregator device of data associated with the aggregator device and aggregating data from the at least one sensor device for which the at least one aggregator device is responsible; send a non-acknowledgment message to the at least one aggregator device when the hub device does not correctly receive sensor data from the at least one sensor device; request the sensor data from the at least one aggregator device; send a non-acknowledgment message to the at least sensor device when the hub device is notified that the aggregator device does not correctly receive the sensor data; request the sensor data from the at least one sensor device from which the missing data originates when the hub device does not correctly receive the retransmitted sensor data from the at least one aggregator device; and send an acknowledgment message to the at least one sensor device and the at least one aggregator device when the hub device correctly receives the retransmitted sensor data. One advantage resides in reducing sensor device power consumption.

Another advantage resides in increasing sensor device battery lives.

Another advantage resides in achieving improved, e.g. medical-grade, communication link robustness.

Another advantage is reduced wireless data traffic on the short-range MBAN.

Still further advantages of the present disclosure will be appreciated to those of ordinary skill in the art upon reading and understand the following detailed description. It will be appreciated that a given embodiment may attain none, one, two, more, or all of these advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the disclosure.

FIGURE 1 illustrates a medical body area network (MBAN) according to the prior art.

FIGURE 2 illustrates an MBAN solution architecture in accordance with one aspect of the present disclosure.

FIGURE 3 illustrates a schematic of an MBAN of FIGURE 2.

FIGURE 4 illustrates a method for transmitting patient data using the MBAN of FIGURE 3.

DETAILED DESCRIPTION

To provide an integrated solution to the above-mentioned problems, more and more medical devices are connected together. Some of those medical devices are not typical "sensor" devices and they can be main, alternating-current (AC) powered or equipped with a big-capacity battery. These devices may generate their own data and/or may need to receive data from sensor devices. By leveraging these devices as additional data aggregators, there can be more than one data aggregator devices in an MBAN network and different devices can have quite different battery/power capacities.

One typical example is an MBAN patient monitoring system used in ICU, which not only includes typical on-body sensor devices, which are tiny and powered by small batteries, to capture patient physiological data, but also includes multiple main (or AC) powered bedside devices, such as a patient monitor, intravenous (IV) pump, ventilator, or anaesthesia machine. Besides the bedside monitor, ventilator machine or anaesthesia machine may also need to receive patient physiological data from on-body sensor devices. For example, the ventilator machine may need patient real-time SpO2 data to optimize its ventilator settings.

Nowadays, most of radio frequency (RF) radios can work on a wide frequency range that may cover several frequency bands. For example, Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 and future IEEE 802.15.6 radios typically work in roughly the 2300-2500 megahertz (MHz) frequency range, which covers the United States MBAN band (i.e., 2360-2400 MHz), the 2.4 gigahertz (GHz) industrial, scientific and medical (ISM) band (i.e., 2400-2483.5 MHz), and the Europe MBAN band (i.e., 2483.5-2400 MHz). The 2.4 GHz ISM band is always available for MBAN operations even if it is "dirty" (i.e., more likely to have interference) compared to the MBAN bands. Hence, the 2.4 GHz ISM band opens door to operate MBANs in different bands simultaneously to offload some traffic from a channel in the MBAN bands to other channel(s) outside the MBAN bands so that the duty cycle limit can be met.

Referring to FIGURE 2, an MBAN solution architecture is shown. A bedside monitor **1** and on-body sensor devices, e.g. an illustrative SpO2 sensor **2**, ECG sensor **3**, and blood pressure (BP) sensor **4**, form a star-topology MBAN network. The bedside monitor **1** is the hub device that maintains the MBAN network and aggregates the data from all the sensor devices **2**, **3**, **4**. Conventionally, each sensor only communicates to the hub device via MBAN to transfer its sensor data. If a data packet is lost during the transmission from a sensor to the hub, then the sensor has to retransmit the packet by itself. Due to patient body movement, the sensor-to-hub links can become weak from time to time and such retransmissions can happen frequently in reality. Those retransmissions can significantly reduce sensor device's battery life. Moreover, retransmissions performed by the same sensor may not be able to guarantee the delivery of the lost data since in many cases, the problem with the communication link between the sensor and the hub that initially caused the lost data may not change too much and still has a bad quality during retransmissions (e.g. patient body blocks the link between the sensor and the hub). To overcome this, some type of diversity scheme is needed. For example, multi-hop relay scheme is introduced in the IEEE 802.15.6, which complicates the network protocols and consume extra sensor device power.

At the same time, a ventilator machine **5** has to setup a communication link **6**, either an MBAN link or other wired or wireless link, to get the SpO2 data from the patient monitor device. For example, a wired link may be provided between the ventilator and the patient monitor via an interface module. This requires extra hardware/software support and reduces system efficiency, in the sense that the SpO2 sensor data has to be transmitted two times, one from the SpO2 sensor to the patient monitor and the other from the patient monitor to the ventilator.

In general, conventional MBAN solutions are not optimized for the applications with multiple data aggregated devices (patient monitor, ventilator, and the like) since: (1) the aggregated sensor data has to be sent multiple times to get to all the aggregated data devices, which reduces system efficiency; and (2) the sensor devices with limited power capacity have to perform data retransmission when there is data loss, which reduces sensor device battery life.

With continuing reference to FIGURE 2, in disclosed embodiments multiple data aggregator devices are provided. In the illustrative example, the ventilator **5** serves as a second aggregator device in addition to the hub **1**. This leverages that fact that the sensors **2**, **3**, **4** of the MBAN are broadcasting their data to the bedside monitor or other hub device. Thus, there is no extra power consumed at the sensor (e.g. SpO2 sensor **2**) if other aggregator devices, such as the illustrative ventilator machine **5**, "eavesdrop" on this broadcast by also receiving the data (as diagrammatically indicated in FIGURE 2 by communication path **7**). This does not consume extra power at the aggregator device **5** since the aggregator does not need to receive the senor data from the hub. In this case, if the hub **1** misses some data sent from the SpO2 sensor **2** for any reason, it can request and receive this data from the aggregator device **5**. This reduces power drain on the miniaturized sensor **2**, and additionally improves robustness by providing a redundant pathway for the SpO2 data to reach the hub **1**. A further advantage is that when the ventilator **5** successfully receives the SpO2 data directly from the broadcast of the SpO2 sensor **2** it does not need to add this traffic to the communication link **6**. In general, the disclosed approach of leveraging a.c.-powered or large battery-powered devices, and especially data consuming devices, as additional aggregators allows the MBAN to leverage the broadcasting nature of wireless communications and make other data aggregator devices also receive their desired sensor data when sensor devices transfer their data to the hub device and allow the data aggregator devices perform data retransmissions for the sensor devices to reduce sensor device power consumption.

With reference to FIGURE 3, in an illustrative embodiment an MBAN system or network **10** is associated with a patient **12**. As shown in FIGURE 3, the MBAN system **10** includes at least one sensor device **14** (more particularly three illustrative sensor devices in FIGURE 3), at least one aggregator device **16**, and a hub device **18**. It will be appreciated that, although only one MBAN system **10** is shown in Figure 3, an environment (such as a medical institution, a nursing home, a patient's home, and the like) can include more than one MBAN system (i.e., one MBAN system per patient **12**). The sensor devices **14,** the aggregator devices **16**, and the hub device **18** can be in communication with each other via a wireless communication network **28** (e.g., a wireless local area network, a personal area network, Zigbee®, and the like). The sensor devices **14,** the aggregator devices **16**, and the hub device **18** are each described in more detail below.

The MBAN system **10** is a low-power, short-range wireless network operating in a dedicated MBAN band, such as the 2300 megahertz (MHz) to 2600 MHz band. The MBAN **10** further operates in one or more other bands, such as the 2.4 GHz ISM band, when approaching the duty cycle limit of the MBAN band. The MBAN band and the other bands are partitioned into channels managed by the hub device **18**. The MBAN **10** is of any type, but typically one of an Institute of Electrical and Electronics Engineers (IEEE) 802.15.6 MBAN and an IEEE 802.15.4 MBAN.

The sensor devices **14** are configured to acquire physiological data of the patient **12**, such as heart rate, respiration rate, blood pressure, electrocardiogram (ECG) signals, blood-glucose levels, oxygen-saturation levels, and so forth, in real-time and forward the data to the hub device **18** over the MBAN **10**. The sensor devices **14** are typically miniature devices that are disposed on the exterior of the patient **12**. For example, the sensor devices **14** can be on-body and/or wearable sensor devices. However, in some embodiments, the sensor devices **14** are additionally or alternatively disposed in the patient **12** and/or proximate to the patient.

Each of the sensor devices **14** is typically a self-contained wireless communicating device, and includes a controller **20**, a wireless communication unit or transceiver **22**, and at least one sensor **24** for measuring at least one physiological parameter of the patient **12**. The controller **20** acquires the physiological data using the sensor **24** and transmits the acquired physiological data directly to the hub device **18** using the communication unit **22**. The controller **20** typically transmits the captured physiological data upon receiving it. However, in some embodiments, the controller **20** buffers or otherwise stores the captured physiological data in at least one storage memory **26** of the sensor device **14** and transmits the buffered physiological data only when the amount exceeds a threshold. The communication unit **22** communicates with the hub device **18** over the MBAN **10**. For example, the communications unit **22** is configured to operate in the frequency band of 2300 Megahertz – 2600 Megahertz. The data acquired by the sensors **24** can be stored in a memory **26**. In some embodiments, the sensor devices **14** are also configured to communicate with the aggregator devices **16** via the communication unit **22**. In other embodiments, the sensor devices **14** are also configured to communicate with the aggregator devices **16** via a separate communication unit (not shown). The sensor device is typically battery-powered by a battery **27**, and is typically miniaturized and light weight to facilitate being unobtrusive when worn by the patient. To achieve miniaturization and to lower the weight, the battery **27** is preferably a small battery and accordingly has limited energy storage. It is therefore desired to minimize power draw on the battery **27** by various mechanisms such as using low-power electronic components, and by wirelessly transmitting sensor data using as low power as possible while still achieving suitable connectivity. It will be recognized that transmitting at low power reduces the signal-to-noise ratio (SNR) and increases likelihood of missing data at the receiver (e.g. the hub **18**).

The aggregator devices **16** can include a mechanical ventilator, an intravenous (IV) infusion pump, an insulin pump, an anesthesia machine, and the like. Each aggregator device typically joins the MBAN to send patient data generated at the aggregator device to the hub, and/or to receive patient data from one or more sensor devices **14** of the MBAN. The aggregator devices are preferably a.c. powered and/or powered by a relatively large battery (e.g. usually a.c. powered but with a backup battery to keep running when unplugged to move to a different location or during an a.c. power outage), so that additional power consumption at the aggregator device due to the device performing data aggregation is acceptable. Each aggregator device **16** includes a communication unit or transceiver **30** configured to communicate with the sensor devices **14**, the hub device **18,** or both. For example, the wireless receiving transceiver **30** is configured to receive the physiological data acquired by the one or more sensor devices **14** from the sensor devices. The receiving transceiver **30** is configured to operate in the frequency band of 2300 Megahertz – 2600 Megahertz. As described in more detail below, the aggregator devices **16** are configured to receive the sensor data from the sensor devices **14**, and transmit the sensor data to the hub device **18** when the hub device is unable to receive the sensor data from the sensor devices **14**.

The illustrative hub device **18** is a patient monitor, such as a local bedside monitoring unit, although another type of hub device is contemplated such as a dedicated hub device mounted on an IV pole to achieve mobility. To save space and reduce the number of components, it is contemplated to integrate the hub device functionality into an IV infusion pump. The hub device **18** is disposed proximate to the patient **12**, or at least within range of the low-power wireless transmissions emitted by the sensor devices **14** on the patient. As described in more detail below, the hub device **18** is configured to: (1) receive the sensor data from the sensor devices **14**; and (2) request and receive the sensor data from the aggregator devices **16** when the hub device is unable to receive the data from the sensor devices **14**. The hub device **18** consumes substantial power compared with the typically miniaturized sensor devices **14**; accordingly, the hub device **18** is preferably a.c. powered and/or powered by a large battery (possibly serving as backup power when unplugged or during an a.c. power outage).

The illustrative hub device **18** includes a controller **32**, a wireless communication unit or transceiver **34,** a data acquisition module **36**, and a device selection module **38**. The controller **32** is programmed to control the operations of the wireless communication unit **34,** the data acquisition module **36**, and the device selection module **38**. The wireless communication unit **34** is programmed to communicate (i.e., send messages) with the sensor devices **14** and the aggregator devices **16**. It will be appreciated that the communication unit **34** is configured to operate in the frequency band of 2300 Megahertz – 2600 Megahertz. The data acquisition module **36** is programmed to receive the acquired physiological data from the sensor devices **14**, or from the aggregator devices **16** when the hub device **18** is unable to receive the data from the sensor devices. The device selection module **38** is programmed to determine whether to receive the physiological data from the sensor devices **14**, or from the aggregator devices **16.** The operation of each of these components **32-38** is described in more detail below.

The device selection module **38** of the hub device **18** is programmed to maintain a list of the aggregator devices **16** for each type of sensor data (e.g., heart rate, respiration rate, blood pressure, electrocardiogram (ECG) signals, blood-glucose levels, oxygen-saturation levels, and the like). The device list includes all the aggregator devices **16** (e.g., mechanical ventilator, an intravenous (IV) infusion pump, an insulin pump, an anesthesia machine, and the like) that are: (1) currently active in receiving such type of sensor data; and (2) willing to do retransmissions for the source sensor device **14**. For each type of sensor data, the device selection module **38** also selects an aggregator device **16** from its aggregator device list as its retransmission agent. The device selection module **38** is programmed to request for retransmission from the aggregator device **16** (instead of the source sensor device **14**) when a retransmission of such type of sensor data is needed.

The communication unit **34** of the hub device **18** is programmed to receive a "join" request message from at least one of the aggregator devices **16** (hereinafter also referred to as a "current" aggregator device). For example, the current aggregator device **16** is configured to notify the hub device **18** of its status and the types of sensor data (e.g. heart rate, respiration rate, blood pressure, electrocardiogram (ECG) signals, blood-glucose levels, oxygen-saturation levels, and the like) when the aggregator device **16** requests to join the MBAN network **10**. In the join request message, the aggregator device **16** is configured to also indicate whether it is available to do retransmissions for the sensor data it selects to receive. The communication unit **34** of the hub device **18** is programmed to receive the join request message from the wireless receiving transceiver **30** of the aggregator device **16**.

When the communication unit **34** of the hub device **18** receives the join request message from the aggregator device **16**, the device selection module **38** of the hub device **18** is programmed to check the types of sensor data that the aggregator device **16** wants to receive and whether it is willing to help at least one of the sensor devices **14** perform retransmissions when a data loss happens on the link between the sensor device **14** and the hub device **18**. The aggregator device **16** determines whether it is willing to serve as an aggregator for a particular sensor device or type of sensor data based on suitable criteria such as signal quality of the data signal received at the aggregator from the sensor device (this signal quality should be of some minimum level in order for the aggregator device to usefully perform the aggregation task), whether the aggregator device has sufficient processing power and data storage, and whether the aggregator device is using the sensor data itself.

If the hub device **18** decides to accept the join request from the aggregator device **16**, the device selection module **38** is programmed to generate a join request response message that includes timing schedule information (e.g. when to transmit, transmission duration, order of transmission, and the like) of the sensor data that the aggregator device **16** tries to receive. The communication unit **34** of the hub device **18** is programmed to send the join request response message to the aggregator device **16.** With such information, the aggregator device **16** knows the time at which the sensor data that it tries to aggregate is transmitted from the sensor devices **14** to the hub device **18** so that it can receive the aggregated sensor data directly from the sensor devices **14**.

If the hub device **18** decides to accept the join request from the aggregator device **16,** and the aggregator device is willing to be an retransmission agent, the device selection module **38** is programmed to update the list of aggregator devices **16** of each type of the sensor data that the aggregator devices plans to aggregate by adding the current aggregator device to the list. At the same time, the device selection module **38** is also programmed to update the retransmission agent of each updated device list, based on the link quality of the links between the aggregator devices **16** in the list and the hub device **18**. Usually, the one with the best link quality will be selected as the retransmission agent. However, other selection criteria (e.g. overload, power constraints, and the like) can also be used.

If the current aggregator device **16** is selected as a retransmission agent by the hub device **18**, the device selection module **38** is programmed to notify the current aggregator device **16** of the types of sensor data that such current aggregator device is responsible for retransmission (i.e., via a message transmitted from the communication unit **34**).

When the current aggregator device **16** joins the MBAN **10**, the aggregator device starts normal transmission/receiving of its own data. The current aggregator device **16** also receives the aggregated sensor data directly from the source sensor device **14** (when it is transmitted to the hub device **18**) following the timing schedule indicated in the join request response message. As a result, when a sensor device **14** transmits its data to the hub device **18**, all the aggregator devices **16** that need to aggregate such sensor data also receive the data.

In some embodiments, the data acquisition module **36** of the hub device **18** correctly receives the sensor data from the sensor devices **14**. When this occurs, the data acquisition module **36** is programmed to send an acknowledgment message to acknowledge the correct reception of the data to the source sensor device **14** and the current aggregator device **16**.

In other embodiments, the data acquisition module **36** of the hub device **18** correctly receives the sensor data from the sensor devices **14**, while the current aggregator device **16** fails to receive the same sensor data. When this occurs, the aggregator device **16** requests the hub device **18** to retransmit the sensor data thereto. Once the communication unit **34** of the hub device **18** receives a retransmission request from the current aggregator device **16**, the data acquisition module **36** is programmed to retransmit the sensor data to the current aggregator device **16** either from the MBAN link, or from other out-of-band link (e.g. wired link, other radio link).

In the further embodiments, the hub device **18** doesn't correctly receive the sensor data from the sensor device **14.** When this occurs, the data acquisition module **36** is programmed to send a non-acknowledgment message to the current aggregator device **16** to indicate the failure of the transmission of the sensor device **14,** and requests the aggregator device to do the retransmission. If the current aggregator device **16** receives the requested retransmission data correctly, it will start the retransmission of the missing sensor data in response to the retransmission request. If the retransmission succeeds, the data acquisition module **36** is programmed to send an acknowledgment message to the source sensor device **14** and the current aggregator device **16** to acknowledge the correct reception of the data that the missing data is retransmitted correctly.

In still further embodiments, if the current aggregator device **16** also does not receive the requested retransmission data correctly, it will reject the request from the hub device **18** with an indicator stating that it also does not have such data. Once the data acquisition module **36** receives the rejection response from the current aggregator device **16**, it will send a retransmission request to the source sensor device **14** requesting for a retransmission by the source sensor data. Both the hub device **18** and the aggregator device **16** that don't correctly receive the sensor data try to receive the retransmitted data. Once the data acquisition module **36** correctly receives the retransmitted data from the source sensor device **14**, it will send an acknowledgment message to the sensor device **14** to acknowledge receipt thereof. Advantageously, by allowing the aggregator devices **16** to collect the same sensor data from the sensor devices **14**, the hub device **18** can consistently receive the data from either the sensor devices **14** or the aggregator devices **16**, thereby preserving the integrity of the MBAN **10**. In addition, the battery life of the hub device **18** is increased by saving power by requesting the sensor data from the aggregator device **16**, rather than repeatedly requesting the data from the sensor devices **14** when a bad connection exists therebetween. Similarly, the power consumption by the hub device **18** is advantageously reduced.

The device selection module **38** of the hub device **18** is further programmed to update the current aggregator device **16** based on the real-time link quality information, aggregator overload information and other related information to optimize the performance of the MBAN **10**.

In some embodiments, the hub device **18** can be configured as a patient monitor that includes a display **40** configured to display trend lines for physiological data acquired by the one or more sensor devices **14.** In other embodiments, it will be appreciated that the communication unit **34** of the hub device **18** can include at least one of a wired communication transceiver and a WiFi communication transceiver. In this instance, the aggregator devices **16** are configured to send the missing data portion to the hub device **18** by communicating with the wired communication transceiver or the WiFi communication transceiver of the hub device. In further embodiments, it will be appreciated that the aggregator devices **16** and the hub device **18** are each alternating current-powered, thereby reducing power consumption and increasing battery life of the aggregator devices and the hub device.

With reference to FIGURE 4, a method **100** of transmitting patient data in an MBAN is provided. The method **100** includes, with a hub device **18**,: receive a request from the at least one aggregator device **16** to join a medical body area network (MBAN) **10** that the hub device is associated with **102**; check the types of sensor data that the at least one aggregator device wants to receive **104**; determine if the at least one aggregator device is willing to help at least one sensor device **14** perform retransmission when data loss happens between transmissions between the at least one sensor device and the hub device **106**; notify the at least one aggregator device of the types of sensor data for which the aggregator device is responsible for retransmission to the hub device **108**; receive data from the at least one aggregator of data associated with the aggregator and aggregating data from the at least one sensor device for which the at least one aggregator is responsible **110**; send a non-acknowledgment message to the responsible aggregator device when the hub device does not correctly receive sensor data from the at least one sensor device to request retransmission from the aggregator device **112**; request the sensor data from the source sensor device when the aggregator device also does not correctly receive the sensor data **114**; and send an acknowledgment message to the at least one sensor and the at least one aggregator device when the hub device correctly receives the retransmitted sensor data **116**;

As used herein, a memory includes one or more of a non-transitory computer readable medium; a magnetic disk or other magnetic storage medium; an optical disk or other optical storage medium; a random access memory (RAM), read-only memory (ROM), or other electronic memory device or chip or set of operatively interconnected chips; an Internet/Intranet server from which the stored instructions may be retrieved via the Internet/Intranet or a local area network; or so forth. Further, as used herein, a processor includes one or more of a microprocessor, a microcontroller, a graphic processing unit (GPU), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), and the like; a controller includes at least one memory and at least one processor, the processor executing processor executable instructions on the memory, or includes specialized hardware implementing a method; a communication unit includes a transceiver; a user input device includes one or more of a mouse, a keyboard, a touch screen display, one or more buttons, one or more switches, one or more toggles, and the like; and a display device includes one or more of a LCD display, an LED display, a plasma display, a projection display, a touch screen display, and the like.

The disclosure has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon reading and understanding the preceding detailed description. It is intended that the disclosure be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

CLAIMS:

1. A Medical Body Area Network (MBAN) (**10**), comprising:

a hub device (**18**) including a wireless communication transceiver (**34**);

one or more sensor devices (**14**) each including a physiological sensor (**24**) for acquiring physiological data and a wireless communication transceiver (**22**) configured to connect with the wireless communication transceiver (**34**) of the hub device (**18**) to wirelessly transmit acquired physiological data to the hub device (**18**); and

one or more aggregator devices (**16**) each including a wireless communication transceiver (**30**) for receiving physiological data acquired by the one or more sensor devices (**14**);

wherein the hub device (**18**) is configured to respond to not wirelessly receiving a missing data portion of physiological data acquired by a sensor device (**14**) by requesting and receiving the missing data portion from an aggregator device (**16**).

2. The MBAN (**10**) of claim 1, wherein the wireless communication transceiver (**22, 34**) of the hub device (**18**) and of the one or more sensor devices (**14**) operates in a frequency band of 2300 Megahertz – 2600 Megahertz.

3. The MBAN (**10**) of claim 1, wherein the hub device (**18**) further includes at least one of a wired communication transceiver (**34**) and a WiFi communication transceiver (**34**), and the one or more aggregator devices (**16**) are configured to send the missing data portion to the hub device (**18**) by communicating with the wired communication transceiver (**34**) or the WiFi communication transceiver (**34**) of the hub device (**18**).

4. The MBAN (**10**) of claim 1, wherein the hub device (**18**) is a patient monitor comprising a display component (**40**) configured to display trend lines for physiological data acquired by the one or more sensor devices (**14**).

5. The MBAN (**10**) of claim 1, wherein

the at least one sensor device (**14**) includes at least one of an electrocardiogram sensor, a heart rate sensor, a blood pressure sensor, a respiratory sensor, a blood-glucose sensor, and an oxygen-saturation sensor; and

the one or more aggregator devices (**16**) include at least one of a mechanical ventilator, an intravenous (IV) infusion pump, an insulin pump, and an anesthesia machine.

6. The MBAN (**10**) of claim 1, wherein the hub device (**18**) is alternating current-powered and the one or more aggregator devices (**16**) are each alternating current-powered.

7. A non-transitory computer readable medium storing instructions executable by a hub device (**18**) including at least one microprocessor (**32, 34, 36, 38**) to perform a method (**100**) for monitoring a patient using a Medical Body Area Network (MBAN) (**10**), the method comprising:

at the hub device (**18**), maintaining a data types list of each type of data collected by at least one sensor device (**14**) of the MBAN (**10**) and an aggregator list of at least one aggregator device (**16**) of the MBAN (**10**) that is currently receiving one or more types of sensor data from the at least one sensor device (**14**); and

at the hub device (**18**), wirelessly receiving data from the at least one sensor device (**14**) and, in response to not wirelessly receiving a missing data portion from the at least one sensor device (**14**), requesting and receiving the missing data portion from an aggregator device (**16**) listed on the aggregator list of the hub device (**18**) as receiving the data type of the missing data portion.

8. The non-transitory computer readable medium of claim 7, further including:

at the hub device (**18**), receiving a request to join the MBAN as an aggregator from the at least one aggregator device (**16**) that the hub device (**18**) is associated with;

with the hub device (**18**), checking the types of sensor data that the at least one aggregator device (**16**) wants to receive;

via a transmission from the hub device (**18**), notifying the at least one aggregator device (**16**) of the types of sensor data for which the aggregator device (**16**) is responsible for retransmission to the hub device (**18**); and

at the hub device (**18**), receiving data from the at least one aggregator device (**16**) of data associated with the aggregator device (**16**) and aggregating data from the at least one sensor device (**14**) for which the at least one aggregator device (**16**) is responsible.

9. The non-transitory computer readable medium of claim 7, further including:

transmitting, from the hub device (**18**) to the at least one aggregator device (**16**), a timing schedule of the sensor data that the at least one aggregator device (**16**) tries to receive in the request when the hub device (**18**) accepts the request from the at least one aggregator device (**16**) to join the MBAN (**10**).

10. The non-transitory computer readable medium of claim 9, further including:

at the hub device (**18**), updating the list of each type of the sensor data that the at least one aggregator device (**16**) plans to aggregate by adding the at least one aggregator device (**16**) to the list when the hub device (**18**) accepts the request from the at least one aggregator device (**16**) to join the MBAN (**10**) and when the at least one aggregator device (**16**) is willing to be a retransmission agent.

11. The non-transitory computer readable medium of claim 7, further including:

sending an acknowledgment message from the hub device (**18**) to the at least one sensor device (**14**) or the at least one aggregator device (**16**) when the hub device (**18**) correctly receives sensor data.

12. The non-transitory computer readable medium of claim 7, further including:

at the hub device (**18**), receiving a retransmission request from the at least one aggregator device (**16**) when the hub device (**18**) correctly receives the sensor data from the at least one sensor device (**14**) and the at least one aggregator device (**16**) fails to receive the same sensor data; and retransmitting the received sensor data from the hub device **(18)** to the at least one aggregator device **(16)**.

13. The non-transitory computer readable medium of claim 7, further including:

sending a non-acknowledgment message from the hub device **(18)** to the aggregator device **(16)** when the hub device **(18)** does not correctly receive sensor data from the at least one sensor device **(14)**;

with the hub device **(18)**, requesting the sensor data from the at least one aggregator device **(16)**; and

with the hub device **(18)**, sending an acknowledgment message to the at least one sensor device **(14)** and the at least one aggregator device **(16)** when the hub device **(18)** correctly receives the retransmitted sensor data.

14. The non-transitory computer readable medium of claim 7, further including:

sending a non-acknowledgment message from the hub device **(18)** to the at least sensor device **(14)** when both the hub device **(18)** and the aggregator do not correctly receive sensor data from the at least one sensor device **(14)**;

with the hub device **(18)**, requesting the sensor data from sensor **(14)**; and

with the hub device **(18)**, sending an acknowledgment message to the at least one sensor device **(14)** and the at least one aggregator device **(16)** when the hub device **(18)** correctly receives the retransmitted sensor data.

15. The non-transitory computer readable medium of claim 7, further including:

with the hub device **(18)**, updating the at least one aggregator device **(16)** with information related to real-time link quality information and aggregator overload information.

16. A Medical Body Area Network (MBAN) system **(10)** for transmitting patient data, the system comprising:

at least one sensor device **(14)** each including a physiological sensor **(24)** for acquiring physiological data and a wireless communication transceiver **(22)**;

at least one aggregator device (**16**) each including a wireless communication transceiver (**30**) for receiving physiological data acquired by the at least one sensor device (**14**);

a hub device (**18**) including a wireless communication transceiver (**34**) configured to connect with the wireless communication transceiver (**22**) of the at least one sensor device (**14**) to wirelessly transmit acquired physiological data to the hub device (**18**), the hub device (**18**) including at least one processor (**32, 36, 38**) programmed to:

receive a request from the at least one aggregator device (**16**) to join the MBAN (**10**) that the hub device (**18**) is associated with;

check the types of sensor data that the at least one aggregator device (**16**) wants to receive;

determine if the at least one aggregator device (**16**) is willing to help the at least one sensor device (**14**) perform retransmission when data loss happens between transmissions between the at least one sensor device (**14**) and the hub device (**18**);

notify the at least one aggregator device (**16**) of the types of sensor data for which the aggregator device (**16**) is responsible for retransmission to the hub device (**18**);

receive data from the at least one aggregator device (**16**) of data associated with the aggregator device (**16**) and aggregating data from the at least one sensor device (**14**) for which the at least one aggregator device (**16**) is responsible;

send a non-acknowledgment message to the aggregator device (**16**) when the hub device (**18**) does not correctly receive sensor data from the at least one sensor device (**14**);

request the sensor data from the at least one aggregator device (**16**); and

send a non-acknowledgment message to the at least sensor device (**14**) when the hub device (**18**) is notified that the aggregator device (**16**) does not correctly receive the sensor data;

request the sensor data from the source sensor device (**14**); and

send an acknowledgment message to the at least one sensor device (**14**) and the at least one aggregator device (**16**) when the hub device (**18**) correctly receives the retransmitted sensor data.

17. The MBAN system **(10)** of claim 16, wherein the at least one processor **(32, 36, 38)** is further programmed to:

transmit, to the at least one aggregator device **(16)**, a timing schedule of the sensor data that the at least one aggregator device **(16)** tries to receives in the request when the hub device **(18)** accepts the request from the at least one aggregator device **(16)** to join the MBAN system **(10)**.

18. The MBAN system **(10)** of claim 17, wherein the at least one processor **(32, 36, 38)** is further programmed to:

maintain a list of (1) each type of data collected by at least one sensor device **(14)** and (2) at least one aggregator device **(16)** that is currently receiving each type of sensor data from the at least one sensor device **(14)**; and

update the list of each type of the sensor data that the at least one aggregator device **(16)** plans to aggregate by adding the at least one aggregator device **(16)** to the list when the hub device **(18)** accepts the request from the at least one aggregator device **(16)** to join the MBAN system **(10)** when the at least one aggregator device **(16)** is willing to be a retransmission agent.

19. The MBAN system **(10)** of claim 16, wherein the at least one processor **(32, 36, 38)** is further programmed to:

send an acknowledgment message to the at least one sensor device **(14)** or the at least one aggregator device **(16)** when the hub device **(18)** correctly receives sensor data.

20. The MBAN system **(10)** of claim 19, wherein the at least one processor **(32, 36, 38)** is further programmed to:

receive a retransmission request from the at least one aggregator device **(16)** when the hub device **(18)** correctly receives the sensor data from the at least one sensor device **(14)** and the at least one aggregator device **(16)** fails to receive the same sensor data; and

retransmit the received sensor data to the at least one aggregator device **(16)**.

1/3

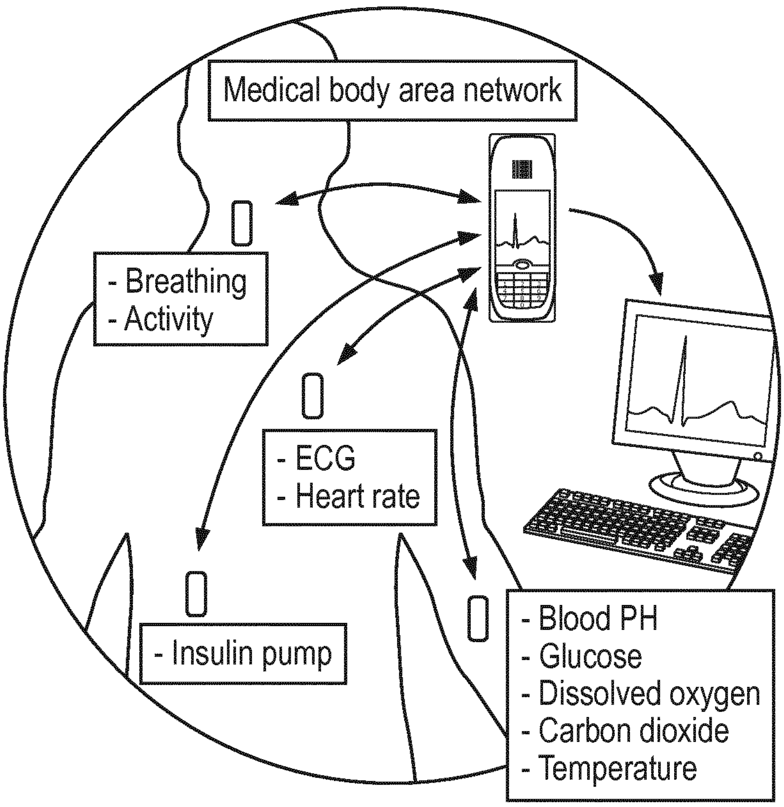

FIG. 1
Prior art

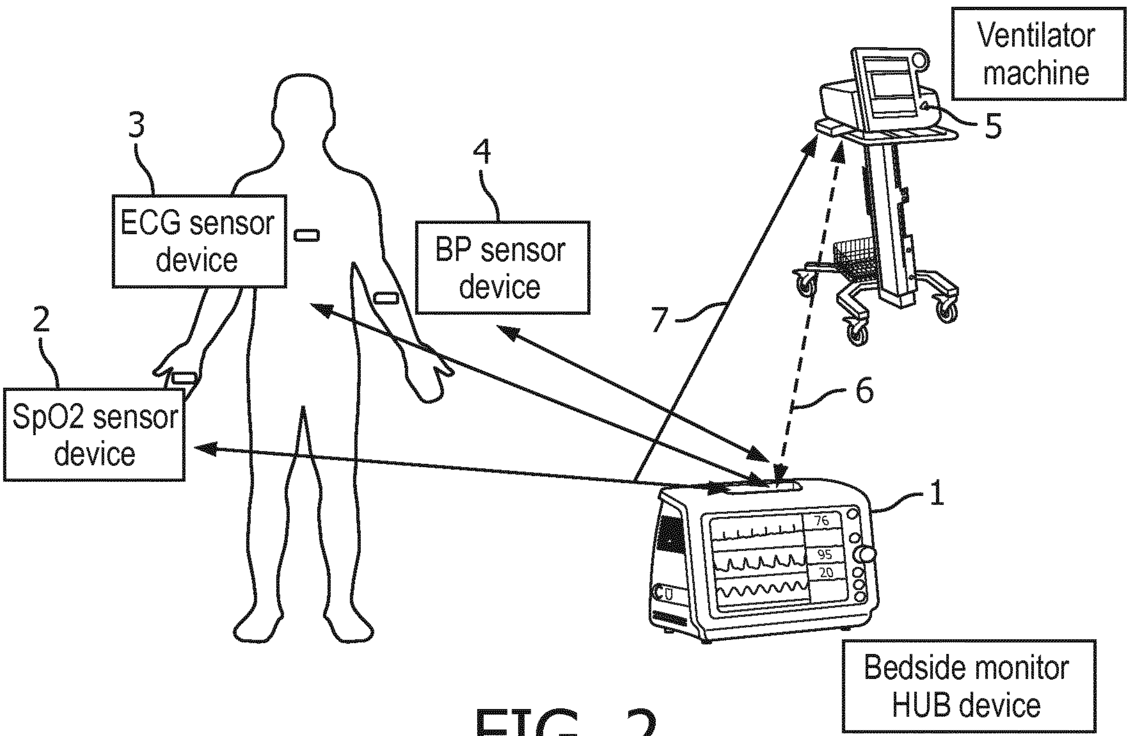

FIG. 2

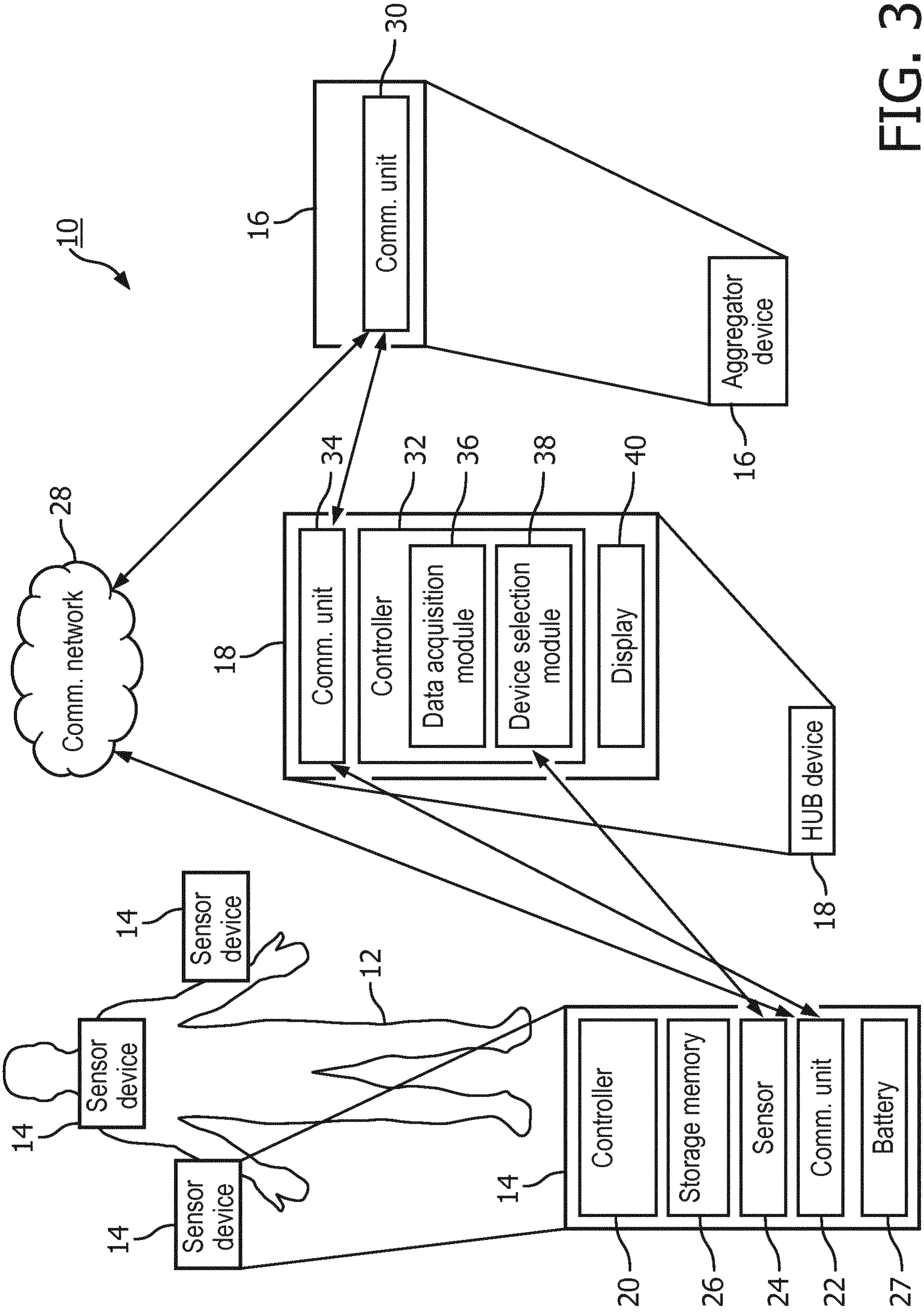
10
Comm. network
28
Comm. unit
30
16
Aggregator device
16
18
Comm. unit
34
Controller
32
Data acquisition module
36
Device selection module
38
Display
40
HUB device
18
Sensor device
14
Sensor device
14
Sensor device
14
12
14
Controller
20
Storage memory
26
Sensor
24
Comm. unit
22
Battery
27

FIG. 3

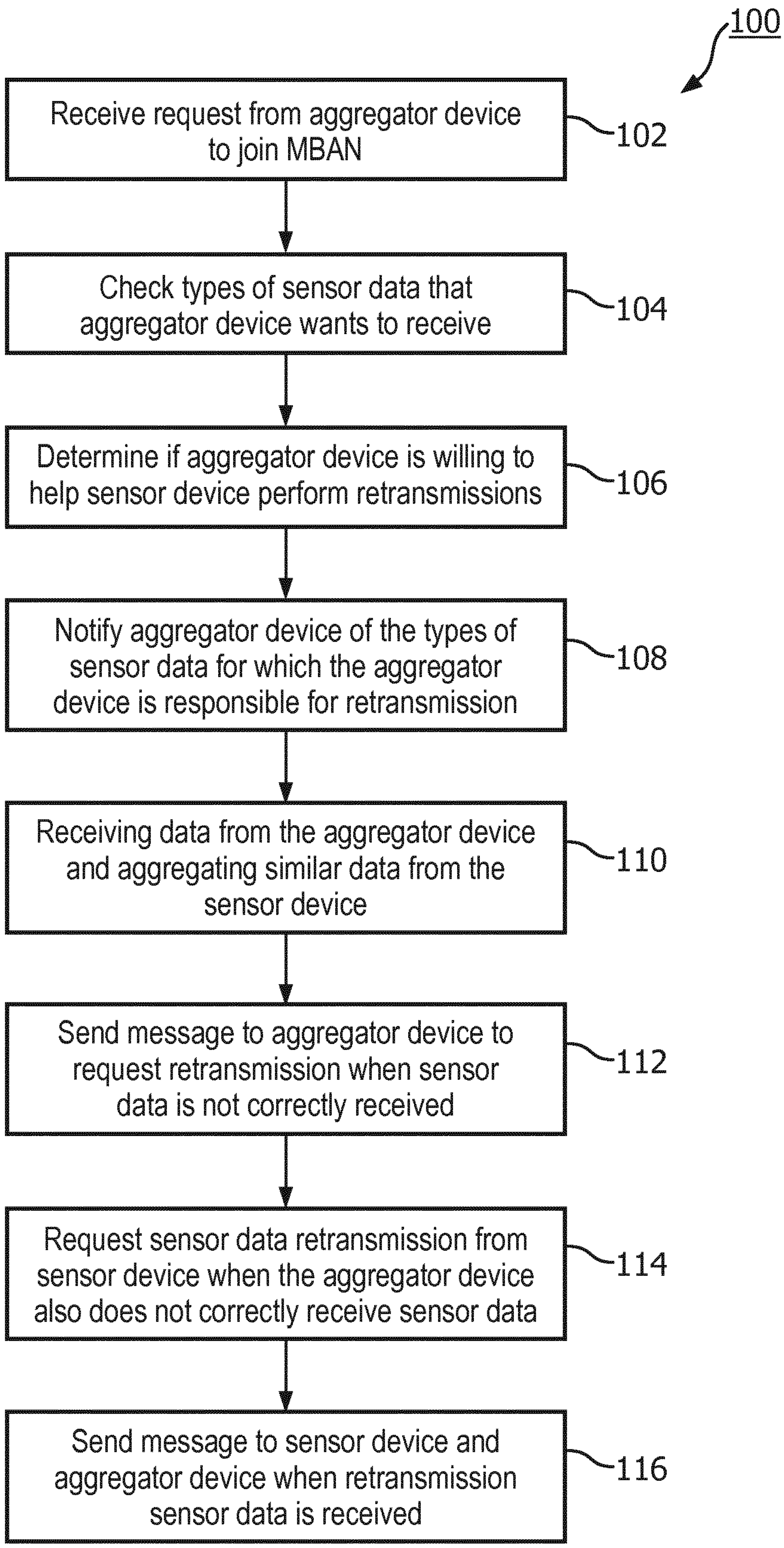
100
Receive request from aggregator device to join MBAN
102
Check types of sensor data that aggregator device wants to receive
104
Determine if aggregator device is willing to help sensor device perform retransmissions
106
Notify aggregator device of the types of sensor data for which the aggregator device is responsible for retransmission
108
Receiving data from the aggregator device and aggregating similar data from the sensor device
110
Send message to aggregator device to request retransmission when sensor data is not correctly received
112
Request sensor data retransmission from sensor device when the aggregator device also does not correctly receive sensor data
114
Send message to sensor device and aggregator device when retransmission sensor data is received
116

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/082247

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00 G08C25/00
ADD. A61B5/0205 H04L1/08 H04W40/00 H04W52/00 H04W84/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B G06F H04L G06Q G08C H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2011/137133 A1 (ESPINA PEREZ JAVIER [DE]) 9 June 2011 (2011-06-09) abstract; figures 1-3 paragraphs [0003], [0006], [0010] - [0024], [0032] - [0036], [0042] - [0058] -----	1-11,15 12-14, 16-20
A	US 2011/196451 A1 (HILL GERARD J [US]) 11 August 2011 (2011-08-11) abstract; figures 1-5 paragraphs [0012] - [0055] -----	1-20
A	US 2015/205931 A1 (WANG DONG [US]) 23 July 2015 (2015-07-23) abstract; figures 1-4 paragraphs [0003] - [0006], [0009] - [0013], [0025] - [0033] -----	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 March 2017	05/04/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Carta, Riccardo

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/082247

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011137133 A1	09-06-2011	AT 556651 T	15-05-2012
		CN 102123656 A	13-07-2011
		EP 2328463 A1	08-06-2011
		JP 5624038 B2	12-11-2014
		JP 2012500084 A	05-01-2012
		RU 2011110516 A	27-09-2012
		US 2011137133 A1	09-06-2011
		WO 2010020945 A1	25-02-2010
US 2011196451 A1	11-08-2011	US 2007299480 A1	27-12-2007
		US 2011196451 A1	11-08-2011
		WO 2008134185 A2	06-11-2008
US 2015205931 A1	23-07-2015	CN 104582562 A	29-04-2015
		EP 2884883 A1	24-06-2015
		JP 2015530901 A	29-10-2015
		RU 2015109001 A	10-10-2016
		US 2015205931 A1	23-07-2015
		WO 2014027273 A1	20-02-2014

专利名称(译)	适用于具有多个聚合器设备的MBAN应用的低功耗无线解决方案		
公开(公告)号	[EP3393338A1](EP3393338A1)	公开(公告)日	2018-10-31
申请号	EP2016823000	申请日	2016-12-21
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	WANG DONG ESPINA PEREZ JAVIER		
发明人	WANG, DONG ESPINA PEREZ, JAVIER		
IPC分类号	A61B5/00 G08C25/00 A61B5/0205 H04L1/08 H04W40/00 H04W52/00 H04W84/00		
CPC分类号	A61B5/0004 A61B5/0006 A61B5/0015 A61B5/0024 A61B5/0205 A61B5/7275 A61B5/742 A61B2560/0209 G16H50/30 H04W40/00 H04W52/0225 Y02D70/142 Y02D70/144 Y02D70/162 Y02D70/26 G06F19/00 Y02D70/00		
代理机构(译)	德哈恩波尔ERIK		
优先权	62/270902 2015-12-22 US		
外部链接	Espacenet		

摘要(译)

本发明涉及一种包括具有用于无线通信的收发器（34）的轮毂装置（18）一种医疗体域网（MBAN）（10）。一个或多个传感器设备（14）的每一个包括用于获取生理数据和用于无线通信的收发器（22）上的生理传感器（24）适于连接到通信的所述收发器（34）无线集线器设备（18），用于无线地发送到所述轮毂（18），所述生理数据获得的。一个或多个聚合器装置（16）的每一个包括用于无线通信的收发器（30），用于接收由所述传感器装置（14）获取的所述生理数据。所述轮毂装置（18）被设计为满足缺少由传感器装置（14）获取的数据的生理数据请求和接收的聚合器装置丢失数据的部分的一部分的非无线接收（16）。