(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 705 682 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.02.2018 Bulletin 2018/09

(21) Application number: **12722544.9**

(22) Date of filing: **27.04.2012**

(51) Int Cl.:
H04W 16/14 *(2009.01)* ***A61B 5/00*** *(2006.01)*
A61B 5/0205 (2006.01) *A61B 5/024 (2006.01)*
A61B 5/0402 (2006.01) *A61B 5/08 (2006.01)*
A61B 5/145 (2006.01) *G06F 19/00 (2018.01)*
H04W 4/00 (2018.01) *H04W 72/04 (2009.01)*
H04W 84/18 (2009.01)

(86) International application number:
PCT/IB2012/052110

(87) International publication number:
WO 2012/150534 (08.11.2012 Gazette 2012/45)

(54) **MBAN CHANNEL USE REGULATION SCHEME AND ADAPTIVE CHANNELIZATION FOR IEEE 802.15.4J STANDARDIZATION**

MBAN-KANAL-VERWENDUNG-REGULIERUNGSSCHEMA UND ADAPTIVE KANALBILDUNG FÜR EINE IEEE-802.15.4J-STANDARDISIERUNG

SYSTÈME DE RÉGULATION D’UTILISATION DE CANAL MBAN ET DÉCOUPAGE EN CANAUX ADAPTATIF POUR NORMALISATION IEEE 802.15.4J

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **02.05.2011 US 201161481441 P**
21.12.2011 US 201161578476 P

(43) Date of publication of application:
12.03.2014 Bulletin 2014/11

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Description

[0001] The present application relates to medical monitoring and clinical data devices for monitoring the physiological condition of a patient. It finds particular application in the use of a channelization scheme and channel use regulation for IEEE 82.15.4j standardization.

[0002] The rapid growth in physiological sensors, low power integrated circuits, and wireless communication has enabled a new generation of medical body area networks (MBAN) to be used to monitor patients. MBANs provide low-cost wireless patient monitoring (PM) without the inconvenience and safety hazards posed by wired connections, which can trip medical personnel or can become detached so as to lose medical data. In the MBAN approach, multiple low cost sensors are attached at different locations on or around a patient. These sensors take readings of patient physiological information such as patient temperature, pulse, blood glucose level, electrocardiographic (ECG) data, or so forth. The sensors are coordinated by at least one proximate hub or gateway device to form the MBAN. The hub or gateway device communicates with the sensors using embedded short-range wireless communication radios, for example, conforming with an IEEE 802.15.4 (Zigbee) short-range wireless communication protocol. Information collected by the sensors is transmitted to the hub or gateway device through the short-range wireless communication of the MBAN, thus eliminating the need for wired connections. The hub or gateway device communicates the collected patient data to a central patient monitoring station via a wired or longer-range wireless link for centralized processing, display and storage. The longer-range network may, for example, include wired Ethernet and/or a wireless protocol such as Wi-Fi or some proprietary wireless network protocol. The PM station may, for example, include an electronic patient record database, display devices located at a nurse's station or elsewhere in the medical facility, or so forth.

[0003] MBAN monitoring acquires patient physiological parameters. Depending upon the type of parameter and the state of the patient, the acquired data may range from important (for example, in the case of monitoring of a healthy patient undergoing a fitness regimen) to life critical (for example, in the case of a critically ill patient in an intensive care unit). Because of this there is a strict reliability requirement on the MBAN wireless links due to the medical content of the data. However, the current spectrum allocations and regulations for medical wireless connectivity do not meet the strict requirements of MBAN, including medical-grade link robustness, ultra low-power consumption, and low-cost, due to either limited bandwidth or uncontrolled interference.

[0004] Frequency spectrum regulation policies try to increase the spectrum use efficiency. One way to increase efficiency is to allocate an opportunistic spectrum specifically for MBAN applications and services as secondary users of a spectrum that has been previously allocated to other services on a primary basis. The basic idea of an opportunistic spectrum is to allow secondary users to opportunistically utilize the spectrum that has been previously allocated to primary users as long as such secondary users do not introduce harmful interference to the primary users. For example, it has been proposed in the U.S. to open the 2360-2400 MHz band (MBAN spectrum), currently assigned to others, to MBAN services as a secondary user. Similar proposals have been made or are expected to be made in other countries. The wide bandwidth, interference-free, and good propagation properties of the MBAN spectrum would meet the strict requirements for medical-grade connectivity. In order to achieve co-existence between primary users and secondary users, some restrictions (or spectrum regulation rulings) would be put on the spectrum use of secondary users.

[0005] For example, when the allocated MBAN spectrum is used on a secondary basis, the secondary user would have to protect the primary users in that spectrum. For example, to protect the primary users, secondary users are often required to provide appropriate mechanisms to vacate the spectrum of the primary user when the primary user wants to use the spectrum. To accomplish this, enforcement mechanisms are needed. The present application proposes a channel use regulation scheme for MBAN systems to guarantee compliance with the MBAN regulations.

[0006] A conventional channelization scheme would define multiple non-overlapping channels in the MBAN spectrum. For example, a channelization scheme for an IEEE 802.15.4j (15.4j) communication standard could define multiple fixed non-overlapping channels in the 2360-2400 MHz band. Since an IEEE 802.15.4j (15.4j) radio has a channel bandwidth of 5 MHz with guard bands at band edges to meet out-of-band-emission (OOBE) limits, then at most, 7 non-overlapping channels could be defined in the 2360-2400 MHz band. For example, 7 channels are defined with a central frequency at 2363, 2368, 2373, 2378, 2383, 2388, and 2395 MHz, respectively. Since the central frequencies of those channels (in MHz) are integers and thus align with the channel central frequencies already defined with an already pre-existing IEEE 802.15.6 (15.6) standard, no 15.6 channel straddles two 15.4j channels. Moreover, the guard bands are fixed (2360-2360.5, 2390.5-2392.5, 2397.5-2400 MHz), so 15.6 radios can choose the 15.6 channels within those guard bands (e.g. 15.6 channels centered at 2391, 2392, 2398, and 2399 MHz) to operate to avoid potential mutual interference with 15.4j systems.

[0007] However, there are some severe drawbacks about this simple channelization scheme. First, there is only one channel defined in the 2390-2400 MHz band. This means for remote monitoring applications deployed outside hospitals, there is only one channel available for 15.4j radio operations. If there exists an amateur radio operating nearby in the 2396-2399 MHz band (e.g. high-rate data mode amateur), then no interference free channel is available for 15.4j radios. Therefore, the simple channelization scheme can't use the spectrum efficiently because the amateur radio only utilizes a 3 MHz spectrum and there is still a 7 MHz idle spectrum available for 15.4j operation.

[0008] Furthermore, such simple channelization scheme may not be able to use the spectrum efficiently when there is portion of spectrum to be protected for primary users. For example, if the MBANS coordinator concludes that a hospital has to avoid using the 2370-2382 MHz spectrum since such spectrum is currently used by primary users, then there are only 3 channels available for that hospital to deploy 15.4j MBANS devices. The simple channelization scheme only uses 15 MHz spectrum (3 channels each with 5 MHz bandwidth) even there are 28 MHz spectrum available in the 2360-2390 MHz band. Such low spectral use efficiency might not be acceptable in some cases. Additionally, some mechanism is needed to regulate the use of 15.4j channels to protect primary users. For example, in the above example, there should be some mechanism to notify MBANS devices that Channel 1, 2, 3 and 4 are prohibited.

[0009] In WO 2006/102538 (A2) a method and system for extended wearable personal area data network is presented. The remote monitoring system includes an on-body network of sensors and at least one analysis device controlled by a hub. The sensors monitor human physiology, activity and environmental conditions. The monitoring system includes a data classifier to take sensor input to determine a condition of the person wearing the remote monitoring system. The remote monitoring system is further able to determine a level of confidence in the determined condition.

[0010] In Jianfeng Wang et al., Emerging cognitive radio applications: A survey, Communications Magazine, IEEE (Volume:49 ,Issue: 3), 2011, a high-level view on how cognitive radio (primarily from a dynamic spectrum access perspective) would support applications such as smart grid, public safety and/or medical applications, the benefits that cognitive radio would bring, and also some challenges that are yet to be resolved, are presented. Further, related standardization that uses cognitive radio technologies to support such emerging applications is illustrated.

[0011] The present application provides a new and improved system and method for MBAN channel use regulation and adaptive channelization which overcomes the above-referenced problems and others.

[0012] In accordance with one aspect, a medical system is provided. The medical system includes one or more medical body area network (MBAN) systems. Each MBAN system includes one or more MBAN devices configured to acquire and communicate patient data with a hub device via short-range wireless communication. The communication of the patient data via the short-range wireless communication being within a predefined spectrum, part of the predefined spectrum being in use by a primary user and unavailable for use. The hub device is configured to receive patient data communicated from the one or more MBAN devices and to communicate with a central monitoring station via a longer range communication. A channel regulator is configured to prohibit the one or more MBAN devices from utilizing at least a portion of the predefined spectrum and to define a channelization scheme with one or more channels of the predefined spectrum accessible to the one or more MBAN devices, wherein the channelization scheme defines one or more non-overlapping channels within the predefined spectrum which can only be accessed within a healthcare facility and one or more overlapping channels within the predefined spectrum which can be accessed anywhere.

[0013] In accordance with another aspect, a method is provided. The method including collecting patient data by one or more medical body area network (MBAN) devices, prohibiting, by a channel regulator, the one or more MBAN devices from utilizing at least a portion of a predefined spectrum, part of the predefined spectrum being in use by a primary user and unavailable for use, defining, by the channel regulator, a channelization scheme with one or more channels of the predefined spectrum accessible to the one or more MBAN devices, wherein the channelization scheme defines one or more non-overlapping channels within the predefined spectrum which can only be accessed within a healthcare facility and one or more overlapping channels within the predefined spectrum which can be accessed anywhere, communicating the collected patient data from the one or more MBAN devices through a MBAN system to a hub device via short-range wireless communication, the communication via short-range wireless communication being within a predefined spectrum, and communicating the collected patient data from the hub device to a central monitoring station via longer range wireless communication.

[0014] There is also provided a computer readable medium containing software which when loaded into processor programs the processor to perform this method described.

[0015] One advantage resides in the efficient utilization of a MBAN spectrum using adaptive channelization and channel use regulation.

[0016] Another advantage resides in the compliance with MBAN regulations.

[0017] Another advantage resides in the coexistence with primary users of a spectrum and other MBAN devices.

[0018] Another advantage resides in improved healthcare workflow efficiency, safety, and clinical outcome.

[0019] Still further advantages of the present invention will be appreciated to those of ordinary skill in the art upon reading and understand the following detailed description.

[0020] Still further advantages of the present invention will be appreciated to those of ordinary skill in the art upon reading and understand the following detailed description.

[0021] The invention 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 invention.

FIGURE 1 diagrammatically illustrates a medical body area network (MBAN) system in accordance with the present application.

FIGURE 2 diagrammatically illustrates a channelization scheme of the MBAN system in accordance with the present application.

FIGURE 3 diagrammatically illustrates another channelization scheme of the MBAN system in accordance with the present application.

FIGURE 4 diagrammatically illustrates another channelization scheme of the MBAN system in accordance with the present application.

FIGURE 5 is a flowchart diagram of the operation of the MBAN system in accordance with the present application.

[0022] FIGURE 1 illustrates a medical body area network (MBAN) 10 which implements a channelization scheme and channel use regulation for IEEE 802.15.4j standardization. In a first channelization scheme, non-overlapping channels are defined in a MBAN spectrum, which can only be accessed within a healthcare facility upon coordination, while overlapping channels are defined in a first portion of the MBAN spectrum, which can be accessed anywhere. Fixed non-overlapping channels defined in a second portion of the MBAN spectrum would simplify implementation and promote coexistence with other in-band MBAN users, such as IEEE 802.15.6 radios and the like, within healthcare facilities. At the same time, overlapping channels defined in the first portion of the MBAN spectrum provide flexibility for out-of-hospital MBAN applications to mitigate mutual interference with other users in the second portion of the MBAN spectrum. A second channelization scheme improves spectral use efficiency in the cases where MBAN systems need to protect primary users' spectrum in the first portion of the MBAN spectrum. A third channelization scheme simplifies the second channelization scheme by defining fewer channels in the MBAN spectrum, which can provide a good tradeoff between spectral use efficiency and implementation complexity. In the latter two cases, overlapping channels are defined in the whole MBAN spectrum to provide more channel choices for MBAN operations. To avoid the use of overlapping channels in healthcare facilities, a new MAC channel mask parameter is introduced to dynamically enable/disable the use of each defined channels. The primitive to set the channel mask parameter ensures that only non-overlapping channels can be enabled within the first portion of the MBAN spectrum such that using overlapping channels in a healthcare facility is prohibited. Non-overlapping channels to be used in a healthcare facility can be dynamically changed to adapt to its spectrum situation. Overlapping channels are allowed in the second portion of the MBAN spectrum to promote coexistence in remote monitoring scenarios. The channel use regulation includes an MBAN regulator which interfaces to an MBAN coordinator and other MBAN devices and is responsible for generating channel use rules for each type of MBAN device based on the E-key/authorization received from the MBAN coordinator and the spectrum use status of other MBANS devices.

[0023] With reference to FIGURE 1, each medical body area network (MBAN) **10** of a plurality of MBANs includes a plurality of MBAN devices **12, 14** and a corresponding hub device **16.** The MBAN devices **12, 14** communicate with the corresponding hub device **16** via a short-range wireless communication protocol. The MBAN **10** is also sometimes referred to in the relevant literature by other equivalent terms, such as a body area network (BAN), a body sensor network (BSN), a personal area network (PAN), a mobile ad hoc network (MANET), or so forth - the term medical body area network (MBAN) **10** is to be understood as encompassing these various alternative terms.

[0024] The illustrative MBANs **10** includes two illustrative MBAN devices **12, 14** and a corresponding hub devices **16;** however, the number of MBAN devices and hub devices can be one, two, three, four, five, six, or more, and moreover the number of MBAN devices may in some embodiments increase or decrease in an *ad hoc* fashion as MBAN devices are added or removed from the network to add or remove medical monitoring capability. The MBAN devices **12, 14** include one or more sensors **20** that acquire patient data including physiological parameters such as heart rate, respiration rate, electrocardiographic (ECG) data, or so forth; however, it is also contemplated for one or more of the MBAN devices to perform other functions such as controlled delivery of a therapeutic drug via a skin patch or intravenous connection, performing cardiac pacemaking functionality, or so forth. Other MBAN devices can be associated with a patient, and not all of the above-mentioned MBAN devices have to be associated with a patient at any given time. A single MBAN device may perform one or more functions. The illustrative MBAN devices **12, 14** are disposed on the exterior of an associated patient; however, more generally the MBAN devices may be disposed on the patient, or in the patient (for example, a MBAN device may take the form of an implanted device), or proximate to the patient within the communication range of the short-range communication protocol (for example, a MBAN device may take the form of a device mounted on an intravenous infusion pump (not shown) mounted on a pole that is kept near the patient, and in this case the monitored patient data may include information such as the intravenous fluid flow rate). It is sometimes desirable for the MBAN devices to be made as small as practicable to promote patient comfort, and to be of low complexity to enhance reliability - accordingly, such MBAN devices **12, 14** are typically low-power devices (to keep the battery or other electrical power supply small) and may have limited on-board data storage or data buffering. As a consequence, the MBAN devices **12, 14** should be in continuous or nearly continuous short-range wireless communication with the corresponding hub device **16** in order to expeditiously convey acquired patient data to the corresponding hub device **16** without overflowing its data buffer.

[0025] In FIGURE 1, the short-range wireless communication range is diagrammatically indicated by the dotted line used to delineate the MBAN system **10.** The short-range wireless communication is typically two-way, so that the MBAN devices **12, 14** can communicate information (e.g., patient data, MBAN device status, or so forth) to the corresponding hub device **16;** and the corresponding hub device **16** can communicate information (e.g., commands, control data in the case of a therapeutic MBAN device, or so forth) to the MBAN devices **12, 14.** The illustrative hub device is a waist-mounted device which facilitates carrying a longer, heavier battery and other hardware for longer range transmissions; however, the hub device can be otherwise mounted to the patient, for example as a wrist device, adhesively glued device, or so forth. It is also contemplated for the hub device to be mounted elsewhere proximate to the patent, such as being integrated with an intravenous infusion pump (not shown) mounted on a pole that is kept near the patient.

[0026] The patient data acquired from the sensors **20** is concurrently transmitted to a controller **22** in the corresponding MBAN device. The MBAN devices **12, 14** serve as a gathering point for the patient data acquired by the sensors **20** and provide temporary storage of the patient data in a memory **24.** The MBAN devices **12, 14** also include a communication unit **26** for transmitting the patient data via short-range wireless communication protocol to the corresponding hub device **16.** The communication unit **26** include a transceiver (not shown) to transmit the patient data and information, received by the controller **22,** and receive information, from the hub device **16.**

[0027] The short-range wireless communication protocol preferably has a relatively short operational range of a few tens of meters, a few meters, or less, and in some embodiments suitably employs an IEEE 802.15.4 (Zigbee) short-range wireless communication protocol or a variant thereof, or a Bluetooth™ short-range wireless communication protocol or a variant thereof. Although Bluetooth™ and Zigbee are suitable embodiments for the short-range wireless communication, other short-range communication protocols, including proprietary communication protocols, are also contemplated. The short-range communication protocol should have a sufficient range for the hub device **16** to communicate reliably with all MBAN devices **12, 14** of the MBAN system **10.** The short-range wireless communication protocol between the MBAN devices **12, 14** and the corresponding hub device **16** and in some embodiments between MBAN devices operate in a frequency spectrum of around 2.3-2.5 GHz.

[0028] Due to the strict reliability requirements on MBAN system **10** communications because of the medical content of the patient data being transmitted, an opportunistic MBAN spectrum is specifically allocated for the communication of the patient data, for example, in the 2360-2400 MHz band discussed above. In the MBAN spectrum, the MBAN devices **12, 14** are secondary users of the spectrum or can use it on a secondary basis meaning the MBAN systems would have to yield to the primary users in that spectrum. To protect the primary user, the MBAN system **10** implements a channelization scheme and channel use regulation. In a first channelization scheme, non-overlapping channels are defined in the MBAN spectrum, which can only be accessed within a healthcare facility upon coordination, while overlapping channels are defined in a first portion of the MBAN spectrum, which can be accessed anywhere. Fixed non-overlapping channels defined in a second portion of the MBAN spectrum would simplify implementation and promote coexistence with other in-band MBAN users. In a second channelization scheme, spectral use efficiency is improved in the cases where MBAN systems need to protect primary users' spectrum in the first portion of the MBAN spectrum. Overlapping channels are defined in the whole MBAN spectrum to provide more channel choices for MBAN operations. To avoid the use of overlapping channels in healthcare facilities, a MAC parameter is introduced to dynamically enable/disable the use of each defined channels. The channel use regulation includes generating channel use rules for each type of MBAN device based on the E-key/authorization received from an MBAN coordinator and the spectrum use status of other MBANS devices. In a third channelization scheme, fewer overlapping channels are defined in the whole MBAN spectrum to provide a good tradeoff between spectral use efficiency and implementation complexity.

[0029] To accomplish this, healthcare facilities which want to access the MBAN spectrum are required to register with an assigned MBAN coordinator **36.** The MBAN coordinator **36** performs MBAN coordination with the healthcare facilities and generates an E-key to authorize access to part or the whole of the MBAN spectrum to the healthcare facilities. Each registered healthcare facility deploys a single centralized control point device **38** that communicates with a controller 40 of the MBAN coordinator **36** and receives (either automatically via network connection or manually via Email, mail or other methods) the E-key. The issued E-key includes authorized frequencies and time period for MBAN operations. A controller **42** of the MBAN control point **38** receives and automatically conveys the E-key information to the MBAN systems **10** deployed within such facility to regulate their uses of the MBAN spectrum.

[0030] The healthcare facility also includes a MBAN channel regulator 44 which is used as an interface between the MBAN control point **38** and the MBAN systems

10. A controller **46** of the MBAN channel regulator 44 receives the E-Key information generated by the MBAN coordinator **36** and translates it into channel use rules for each type of MBAN system **10** within the healthcare facility that are stored in a MBAN rules database 48. The MBAN channel regulator 44 also interfaces to each type of MBAN systems, such as 15.4j radios, 15.6 radios, and other proprietary systems. The controller **46** of the MBAN channel regulator 44 forwards the corresponding channel uses rules to each type of MBAN system **10** to regulate their uses of the MBAN spectrum. The MBANS channel regulator 44 also provides a user interface **50** (via network connection or local connection) for hospital MBAN system administrators to customize those channel use rules. Additionally, each MBAN system **10** feedbacks their channel use information to the MBAN channel regulator 44. Based on channel use information, the MBAN regulator 44 generates the MBAN spectrum use report and forwards the report to MBAN control point **38** and MBANS coordinator **36** to monitor the MBAN spectrum use. Moreover, the MBAN channel regulator 44 has the channel use information of all deployed MBAN systems **10** and can use such information to optimize the channel use of each type of MBAN systems **10.** For example, the MBAN channel regulator 44 can generate a prioritized channel list for each type of MBANS system to assist MBANS systems to select their operating channels.

[0031] For example, if the issued E-key indicates that only 2360-2370 and 2382-2390 MHz bands are authorized for MBAN operation (or in other words, the 2370-2382 MHz spectrum is in use by the primary users and should be protected) then the MBAN channel regulator 44 translates such E-key information into channel use rules that are forwarded to all MBAN systems **10** to prohibit the use of specific channels to protect the 2370-2382 MHz spectrum. The MBAN channel regulator 44 also generates channel rules based on its E-key information to enable certain channels for general MBAN use and enable other channels to be used for high priority MBAN use. For example, the MBAN channel regulator 44 may translate the E-key information into 15.4j channel use rules authorizing channels 0 (2363 MHz), 5 (2388 MHz), and 6 (2393 MHz) to be enabled while the other channels are disabled to ensure that 15.4j MBAN radios only use the authorized spectrum, assuming the first channelization scheme is adopted. Such rules are forwarded to all 15.4j MBANS systems to prohibit the use of channel 1, 2, 3, and 4 to protect the 2370-2382 MHz spectrum. If the hospital also deploys 802.15.6 based MBANS systems, the MBANS channel regulator 44 generates the channel rules based on its E-key information and the 15.4j channel use rules it maintains as channels 0, 1,..., 8, 22, 23, ...,37 and 38 are enabled and channels 22, 23, 24, 30, 31, 37 and 38 used with high priority. Channel 22, 23, 24, 30, 31, 37 and 38 have high priority because they are located within the gaps that the current 802.15.4 channel use rules prohibit 15.4j MBAN radios to access. Such 15.6 channel use rules promote 802.15.4j/802.15.6 coexistence performance.

[0032] Moreover, the MBAN administrator of the hospital can customize the MBAN spectrum planning by customizing the channel use rules for different areas within hospitals. Since MBAN systems usually connect to the healthcare facility IT network either via wireless access points or wired Ethernet port and the MBANS channel regulator 44 receives location information of wireless APs and Ethernet ports of healthcare IT networks, the MBAN administrator can customize MBAN channel use rules for wireless APs and Ethernet ports within specific areas to control MBANS spectrum use of MBANS systems associated with those APs and ports. For example, in an emergence room (ER) area, numerous patients could be wearing MBAN systems to monitor their physiological status. To support such high density deployment, the MBAN administrator may limit the number of enabled channels and reserve more spectrums for specific MBAN systems since some specific MBAN systems have a narrower channel and can provide more channels for operation. For example, if the E-key authorizes a hospital to access the whole 2360-2390 MHz band, instead of defining the channel use rules to enable all the channels defined, the MBAN administrator can customize the channel use rules for the ER area and only enable certain channels while enabling all the channels and giving the other channels high priority. These customized rules would provide sufficient channels for MBANS operations and promote coexistence between different types of MBAN devices.

[0033] The hub device **16** coordinates operation of its MBAN system **10** over the MBAN spectrum to receive the patient data acquired by the sensors **20** of the MBAN devices **12, 14** and transmits the collected patient data from the MBAN **10** via a longer range communication protocol to a central monitoring station **34.** The patient data acquired from the sensors **20** is concurrently transmitted from the MBAN devices **12, 14** to a short range communication device **28** in the corresponding hub device **16.** The hub device **16** serves as a gathering point for the patient data acquired by the sensors **20** of all the MBAN device **12, 14** in the MBAN network, e.g. all of the MBAN devices associated with one patient, and provides temporary storage of the patient data in a memory **30.** The hub device **16** also includes a longer range communication unit **32** for transmitting the patient data via a longer range wireless communication protocol to the central monitoring station **34.** A controller **33** of the MBAN hub **16** controls communication with the MBAN devices **12, 14,** collection and handling of the patient data, retransmission of the patient data to a central monitoring station **34,** receiving acknowledgements, setting up the network, associating new MBAN devices, disassociating removed MBAN devices, and the like.

[0034] The longer range communication unit **32** of the hub device **16** also includes a transceiver which provides the longer-range communication capability to communicate data from the MBAN system **10.** In the illustrative example of FIGURE 1, the hub device **16** wirelessly communicates with a central monitoring station **34** through an AP **52** of a hospital network **54.** The illustrative AP **52** is a wireless access point that communicates wirelessly with the hub device **16.** In the illustrative embodiment, the hospital network **54** also includes additional access points, such as illustrative access points AP **56** and AP **58** that are distributed throughout the hospital or other medical facility. To provide further illustration, a central monitoring station is diagrammatically indicated, which is in wireless communication with the AP **56.** Different APs **52, 56-58** cover different areas of the healthcare facility and their coverage areas could overlap with each other to provide seamlessly roaming service.

[0035] To provide further illustration, the central monitoring station **34** includes a controller **60** for receiving the patient data from many hub devices. The central monitoring station **34** also includes a display monitor **62** that may, for example, be used to display medical data for the patient that are acquired by the MBAN system **10** and communicated to the central monitoring station **34** via the AP **56** of the hospital network **54.** The central monitoring station **34** also communicates with an electronic patient records sub-system **64** in which patient data and records for all current and past patients is stored. Communication between the central monitoring stations and the electronic patient records sub-system **64** is communicated via APs **52, 56** of the hospital network **54.** The longer-range wireless communication is suitably a WiFi communication link conforming with an IEEE 802.11 wireless communication protocol or a variant thereof. However, other wireless communication protocols can be used for the longer-range communication, such as another type of wireless medical telemetry system (WMTS). Moreover, the longer range communication can be a wired communication such as a wired Ethernet link (in which case the hospital networks include at least one cable providing the wired longer range communication link).

[0036] The longer range communication has longer range as compared with the short-ranger communication between the MBAN devices **12, 14** and the corresponding hub device **16.** For example, the short-range communication range may be of order a meter, a few meters, or at most perhaps a few tens of meters. The longer range communication can be long enough to encompass a substantial portion or all of the hospital or other medical facility whether directly or via the plurality of APs to the hospital network.

[0037] The longer-range communication, if wireless, requires more power than the short-range communication. Accordingly, the hub device **16** includes a battery or other power source sufficient to operate the longer-range communication transceiver. The hub device **16** also typically includes sufficient on-board storage so that it can buffer a substantial amount of patient data in the event that communication with the hospital network **54** is interrupted for some time interval. In the illustrative case of wireless longer-range communication, it is also to be understood that if the patient moves within the hospital or healthcare facility then the IEEE 802.11 or other wireless communication protocol employed by the hospital network **54** provides for the wireless communication. In this regard, although the patient may be confined to a bed, more generally it is contemplated that the patient may be ambulatory and moving around the hospital or healthcare facility. As the patient moves, the MBAN system **10,** including the MBAN devices **12, 14** and the hub device **16,** move together with the patient.

[0038] In the MBAN system **10,** the MBAN devices **12, 14** communicate with the hub device **16** via the short-range wireless communication. However, it is also contemplated for various pairs or groups of the MBAN devices **12, 14** to also intercommunicate directly (that is, without using the hub devices **16, 18** as an intermediary) via the short-range wireless communication. This may be useful, for example, to coordinate the activities of two or more MBAN devices in time. Moreover, the hub devices **16, 18** may provide additional functionality. For example, the hub devices **16, 18** may also be a MBAN device that includes one or more sensors for measuring physiological parameters. Still further, while the single hub devices **16, 18** is illustrated, it is contemplated that an MBAN system can have two or more hubs that cooperatively perform the task of coordinating functionality (e.g. data collection from the MBAN devices **12, 14** and offloading the collected data via the longer range wireless communication).

[0039] In illustrative FIGURE 1, only one MBAN system **10** is illustrated in detail. However, it will be appreciated that more generally the hospital or other medical facility includes a plurality of patients, each having his or her own MBAN system. More generally, the number of MBAN systems may be, by way of some illustrative examples: the hundreds, thousands, tens of thousands, or more depending on the size of the medical facility. Indeed, it is even contemplated for a single patient to have two or more different, independently or cooperatively operating MBAN systems (not illustrated). In this environment, various MBAN systems of different patients can be expected to come into close proximity with one another, such that the ranges of the respective MBAN system short-range wireless communications overlap.

[0040] The MBAN devices **12, 14,** the MBAN hub **16,** the MBAN system **10,** the MBAN coordinator **36,** the MBAN control point **38,** the MBAN channel regulator 44, and the central monitoring station **34** in the illustrative embodiment include at least one processor, for example a microprocessor or other software controlled device configured to execute MBAN software for performing the operations described in further detail below. Typically, the MBAN software is carried on tangible memory or a computer readable medium for execution by the processor. Types of non-transitory computer readable media include memory such as a hard disk drive, CD-ROM, DVD-ROM, internet servers, and the like. Other implementations of the processor are also contemplated. Display controllers, Application Specific Integrated Circuits (ASICs), FPGAs, and microcontrollers are illustrative examples of other types of component which may be implemented to provide functions of the processor. Embodiments may be implemented using software for execution by a processor, hardware, or some combination thereof.

[0041] With reference to FIGURE 2, a first channelization scheme utilizing overlapping channels in the MBAN spectrum is illustrated. The first channelization scheme avoids strong adjacent channel interference caused by the use of overlapping channels in such a spectrum by defining fixed non-overlapping channels in a second portion of the MBAN spectrum, which can only be accessed within a healthcare facility. This is important for in-healthcare-facility deployment in-healthcare-facility deployment has higher MBANS system density and adjacent channel interference is likely to happen. This channelization scheme along with the system architecture regulates the use of MBAN spectrum channels. Specifically, the upper layer protocol (e.g. network layer protocol or application layer protocol) of the MBAN hub device defines a new channel mask parameter, *ChannelEnabled,* which dynamically enable/disable access to each defined MBAN channel. For example, by default, *ChannelEnabled* is set to only enable channels 6-10 **100,** which are inside the MBAN spectrum band **102.** This would allow MBANS devices to access enabled channels inside the MBAN spectrum band anywhere (i.e. inside healthcare facility and outside healthcare facility). Once an MBAN hub device establishes a valid connection to the healthcare IT network of a healthcare facility, it can obtain the channel use rules from its backhaul access point (AP) device (when via wireless link) or from the channel regulator directly (when via wired port connection) and set its *ChannelEnabled* accordingly. It broadcasts this parameter to other MBAN devices associated with its network. The MBAN hub device only selects an enabled channel to operate. Once an MBAN hub device lose its connection to the healthcare IT network, its *ChannelEnabled* parameter resets to its default value that only enables specified channels.

[0042] In the first channelization scheme, the central frequencies of non-overlapping channels are fixed in the MBAN spectrum band and limit MBAN systems to use the spectrum efficiently when there is portion of a primary user spectrum to be protected. In order to solve this problem, a second channelization scheme utilizes overlapping channels with channel steps defined in the MBAN spectrum band and a new parameter, *MacChannelEnabled,* included in the MAC layer protocol to dynamically enable/disable those overlapping channels. The second channelization scheme is illustrated in FIGURE 3 in which 35 overlapping channels **110** are defined with a channel step of 1 MHz.

[0043] The MAC layer provides a primitive/service call MLME-Set to the upper layer protocol to set the parameter *MacChannelEnabled.* The MLME-Set primitive checks if the input value of *MacChannelEnabled* from the upper layer is a valid one, in terms of if it enables overlapping channels in the MBAN spectrum band. If the input value does enable a portion of those channels in the MBAN spectrum band that overlap with each other, the MLME-SET treats it as an invalid parameter and does not update the MAC parameter *MacChannelEnabled* and returns "Invalid Input Parameter" to the upper layer protocol. Otherwise, MLME-SET updates *MacChannelEnabled* to dynamically update the enabled MBAN spectrum channels that the MBAN system can access. This input value validation enables non-overlapping channels to be enabled in the MBAN spectrum band even though overlapping channels are defined within the spectrum. This is important to keep the PHY/MAC implementation complexity low since, for example, there are at most 6 channels (non-overlapping channels), instead of 30 defined overlapping channels, in the MBAN spectrum band to manage and avoid the adjacent channel interference introduced by the use of overlapping channels in the MBAN spectrum within healthcare facility.

[0044] The third channelization scheme is illustrated in FIGURE 4 in which 15 overlapping channels **110** are defined to provide a good tradeoff between spectral use efficiency and implementation complexity.

[0045] Although the three channelization schemes provide the same advantages, the difference of the second and third channelization scheme from the first channelization scheme is that the non-overlapping channels in the MBAN spectrum band are not fixed and their central frequencies can be adapted to the primary user spectrum availability to achieve the best spectrum efficiency. For example, if the MBAN coordinator decides that a hospital has to avoid using the a portion of a spectrum since such spectrum is currently used by primary users, then the upper layer protocol may receive the channel use rules generated by the MBANS channel regulator and call MLME-SET to set *MacChannelEnabled* to enable Channel 0, 22, 27 &32, as shown in FIGURE 4. The second channelization scheme can provide 4 non-overlapping channels, instead of 3 for the first channelization scheme, for in-healthcare facility deployment and achieves higher spectrum efficiency.

[0046] The second and third channelization schemes can also incorporate seamlessly with the proposed system architecture to regulate the use of MBAN spectrum channels. For in-healthcare-facility deployment, the upper layer protocol of MBAN hub devices can get the channel use rules from the MBAN channel regulator via its backhaul connection to the Healthcare IT network. The upper layer protocol uses MLME-SET primitive to set the MAC parameter *MacChannelEnabled* to dynamically select/enable non-overlapping channels in the MBAN spectrum band for MBAN operations. When an MBAN hub device loses its connection to the healthcare IT network, e.g. patient moving out the hospital, the *MacChannelEnabled* resets to its default value, with which only the overlapping channels within the MBAN spectrum band are enabled.

[0047] With reference to FIGURE 5, a flowchart diagram of the operation of the MBAN system is illustrated. In a step **200,** patient data is collected by one or more medical body area network (MBAN) devices. In a step **202,** the one or more MBAN are prohibited from utilizing at least a portion of a predefined spectrum, part of the predefined spectrum being in use by a primary user and unavailable for use. A channelization scheme is defined with one or more channels of the predefined spectrum accessible to the one or more MBAN devices, the channelization scheme maximizing a number of channels in one or more portions of the spectrum not in use by the primary user in a step **204.** In a **step 206,** the collected patient data is communicated from the one or more MBAN devices through a MBAN system to a hub device via short-range wireless communication. The collected patient data is communicated from the hub device to a central monitoring station via longer range wireless communication in a step **208.**

[0048] The invention has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon reading and understanding the preceding detailed description.

Claims

1. A medical system comprising:

    one or more medical body area network, MBAN, systems **(10),** each MBAN system **(10)** including:

        one or more MBAN devices **(12)** configured to acquire and communicate patient data with a hub device **(16)** via short-range wireless communication, the communication of the patient data via the short-range wireless communication being within a predefined spectrum, part of the predefined spectrum being in use by a primary user and unavailable for use;
        the hub device **(16)** configured to receive patient data communicated from the one or more MBAN devices **(12),** and to communicate with a central monitoring station **(34)** via a longer range communication;
        a channel regulator **(44)** configured to prohibit the one or more MBAN devices **(12)** from utilizing at least a portion of the predefined spectrum and to define a channelization scheme with one or more channels of the predefined spectrum accessible to the one or more MBAN devices **(12),**
        wherein the channelization scheme defines one or more non-overlapping channels within the predefined spectrum which can only be accessed within a healthcare facility and one or more overlapping channels within the predefined spectrum which can be accessed anywhere.

2. The medical system according to claim 1, wherein the channel regulator **(44)** is configured to generate channel use rules of the predefined spectrum for the one or more MBAN devices **(12)** according to a received spectrum authorization and monitored usage of the predefined spectrum.

3. The medical system according to claim 2, wherein the channel use rules disable the one or more MBAN devices **(12)** from transmitting on one or more channels within the predefined spectrum.

4. The medical system according to either one of claims 2 and 3, wherein the channel regulator **(44)** includes:

    an interface **(50)** configured to enable customization of the channel use rules.

5. The medical system according to any one of claims 1-4, wherein the channel regulator **(44)** is configured to define the channelization scheme to maximize a number of channels in one or more portions of the spectrum not in use by the primary user.

6. The medical system according to any one of claims 1-5, wherein the channel regulator **(44)** is configured to define a channelization scheme with one or more overlapping channels in the predefined spectrum to optimize usage of one or more available portions of the predefined spectrum.

7. The medical system according to claim 6, wherein a MAC parameter is defined to dynamically enable or disable access to each defined channel.

8. The medical system according to any one of claims 1-7, wherein the one or more MBAN devices **(12)** are configured to operate at sufficiently low power that the short-range wireless communication is limited to within a medical facility and wherein the channel regulator **(44)** is configured to define a custom channelization scheme for its medical facility.

9. A method comprising:

    collecting patient data by one or more medical body area network, MBAN, devices **(12);** prohibiting, by a channel regulator, the one or more MBAN devices **(12)** from utilizing at least a portion of a predefined spectrum, part of the predefined spectrum being in use by a primary user and unavailable for use;

defining, by the channel regulator, a channelization scheme with one or more channels of the predefined spectrum accessible to the one or more MBAN devices **(12)** wherein the channelization scheme defines one or more non-overlapping channels within the predefined spectrum which can only be accessed within a healthcare facility and one or more overlapping channels within the predefined spectrum which can be accessed anywhere;
communicating the collected patient data from the one or more MBAN devices **(12)** through a MBAN system **(10)** to a hub device **(16)** via short-range wireless communication, the communication via short-range wireless communication being within a predefined spectrum; and
communicating the collected patient data from the hub device **(16)** to a central monitoring station **(34)** via longer range wireless communication.

10. The method according to claim 9, further including:

generating channel use rules of the predefined spectrum for the one or more MBAN devices **(12)** according to monitored usage of the predefined spectrum.

11. The method according to claim 10, further including:

disabling the one or more MBAN devices **(12)** from transmitting on one or more channels within the predefined spectrum according to the channel use rules.

12. The method according to any one of claims 9-11, wherein
the channelization scheme maximizes a number of channels in one or more portions of the spectrum not in use by the primary user.

13. The method according to any one of claims 9-12, further including:

defining a custom channelization scheme for other medical facilities with one or more overlapping channels in the predefined spectrum to optimize usage of one or more available portions of the predefined spectrum .

14. A computer readable medium containing software which when loaded into processor programs the processor to perform the method according to any one of claims 9-13.

Patentansprüche

1. Medizinischs System, umfassend:

ein oder mehrere medizinische körpernahe Netzwerksystem (medical body area network, MBAN) (10), wobei jedes MBAN-System (10) Folgendes umfasst:

ein oder mehrere MBAN-Vorrichtungen (12), die konfiguriert sind, um Patientendaten mit einer Hub-Vorrichtung (16) über drahtlose Kommunikation mit kurzer Reichweite zu erfassen und zu kommunizieren, wobei die Kommunikation der Patientendaten über die drahtlose Kommunikation mit kurzer Reichweite innerhalb eines vordefinierten Spektrums erfolgt, wobei ein Teil des vordefinierten Spektrums durch einen primären Benutzer verwendet wird und nicht zur Nutzung zur Verfügung steht;

die Hub-Vorrichtung (16), die konfiguriert ist, um von der einen oder mehreren MBAN-Vorrichtungen (12) kommunizierte Patientendaten zu empfangen und über eine Kommunikation mit größerer Reichweite mit einer zentralen Überwachungsstation (34) zu kommunizieren;
einen Kanalregulator (44), der konfiguriert ist, um der einen oder mehreren MBAN-Vorrichtungen (12) die Nutzung von mindestens einem Bereich des vordefinierten Spektrums zu untersagen und ein Kanalschema zu definieren, bei dem ein oder mehrere Kanäle des vordefinierten Spektrums für die eine oder mehrere MBAN-Vorrichtungen (12) zugänglich sind,
wobei das Kanalschema einen oder mehrere nicht-überlappende Kanäle innerhalb des vordefinierten Spektrums definiert, die nur innerhalb einer Gesundheitseinrichtung zugänglich sind, und einen oder mehrere überlappende Kanäle innerhalb des vordefinierten Spektrums definiert, die überall zugänglich sind.

2. Medizinisches System nach Anspruch 1, wobei der Kanalregulator (44) konfiguriert ist, um Kanalnutzungsregeln des vordefinierten Spektrums für die eine oder mehrere MBAN-Vorrichtungen (12) entsprechend einer empfangenen Spektrumautorisierung und überwachten Nutzung des vordefinierte Spektrums zu generieren.

3. Medizinisches System nach Anspruch 2, wobei die Kanalnutzungsregeln die eine oder mehrere MBAN-Vorrichtungen (12) daran hindern, auf einem oder mehreren Kanälen innerhalb des vordefinierten Spektrums zu senden.

4. Medizinisches System nach einem der Ansprüche 2 und 3, wobei der Kanalregulator (44) Folgendes umfasst:

eine Schnittstelle (50), die konfiguriert ist, um die Anpassung der Kanalnutzungsregeln zu ermöglichen.

5. Medizinisches System nach einem der Ansprüche 1 bis 4, wobei der Kanalregulator (44) konfiguriert ist, um das Kanalschema so zu definieren, dass eine Anzahl von Kanälen in einem oder mehreren Bereichen des Spektrums, die nicht durch den primären Nutzer genutzt werden, zu maximieren.

6. Medizinisches System nach einem der Ansprüche 1 bis 5, wobei der Kanalregulator (44) konfiguriert ist, um ein Kanalschema mit einem oder mehreren überlappenden Kanälen in dem vordefinierten Spektrum zu definieren, um die Nutzung von einem oder mehreren verfügbaren Bereichen des vordefinierten Spektrums zu optimieren.

7. Medizinisches System nach Anspruch 6, wobei ein MAC-Parameter definiert ist, um den Zugang zu jedem definierten Kanal dynamisch zu ermöglichen oder zu verhindern.

8. Medizinisches System nach einem der Ansprüche 1 bis 7, wobei die eine oder mehrere MBAN-Vorrichtungen (12) konfiguriert sind, um mit ausreichend niedriger Leistung zu arbeiten, damit die drahtlose Kommunikation mit kurzer Reichweite auf das Innere der medizinische Einrichtung begrenzt wird, und wobei der Kanalregulator (44) konfiguriert ist, um ein angepasstes Kanalschema für seine medizinische Einrichtung zu definieren.

9. Verfahren, umfassend:

Erfassen von Patientendaten durch eine oder mehrere medizinische körpernahe Netzwerkvorrichtungen (medical body area network, MBAN) (12);
Untersagen, durch einen Kanalregulator, der Nutzung von mindestens einem Bereich eines vordefinierten Spektrums durch die eine oder mehrere MBAN-Vorrichtungen (12), wobei ein Teil des vordefinierten Spektrums durch einen primären Nutzer verwendet wird und nicht zur Nutzung zur Verfügung steht;
Definieren, durch den Kanalregulator, eines Kanalschemas, bei dem ein oder mehrere Kanäle für die eine oder mehrere MBAN-Vorrichtungen (12) zugänglich sind, wobei das Kanalschema einen oder mehrere nicht-überlappende Kanäle innerhalb des vordefinierten Spektrums definiert, die nur innerhalb einer Gesundheitseinrichtung zugänglich sind, und einen oder mehrere überlappende Kanäle innerhalb des vordefinierten Spektrums definiert, die überall zugänglich sind;
Kommunizieren der erfassten Patientendaten von der einen oder mehreren MBAN-Vorrichtungen (12) über ein MBAN-System (!0) an eine Hub-Vorrichtung (16) mittels drahtloser Kommunikation mit kurzer Reichweite, wobei die Kommunikation mittels Kommunikation mit kurzer Reichweite innerhalb eines vordefinierten Spektrums erfolgt; und
Kommunizieren der erfassten Patientendaten von der Hub-Vorrichtung (16) an eine zentrale Überwachungsstation (34) mittels drahtloser Kommunikation mit größerer Reichweite.

10. Verfahren nach Anspruch 9, weiterhin umfassend:

Generieren von Kanalnutzungsregeln des vordefinierten Spektrums für die eine oder mehrere MBAN-Vorrichtungen (12) entsprechend der überwachten Nutzung des vordefinierten Spektrums.

11. Verfahren nach Anspruch 10, weiterhin umfassend:

Hindern der einen oder mehreren MBAN-Vorrichtungen (12) entsprechend den Kanalnutzungsregeln, auf einem oder mehreren Kanälen innerhalb des vordefinierten Spektrums zu senden.

12. Verfahren nach einem der Ansprüche 9 bis 11, wobei das Kanalschema eine Anzahl von Kanälen in einem oder mehreren Bereichen des Spektrums, die nicht durch den primären Nutzer genutzt werden, maximiert.

13. Verfahren nach einem der Ansprüche 9 bis 12, weiterhin umfassend:

Definieren eines angepassten Kanalschemas für andere medizinische Einrichtungen mit einem oder mehreren überlappenden Kanälen in dem vordefinierten Spektrum, um die Nutzung von einem oder mehreren verfügbaren Bereichen des vordefinierten Spektrums zu optimieren.

14. Computerlesbares Medium enthaltend Software, die, wenn sie in den Prozessor geladen wird, den Prozessor veranlasst, das Verfahren nach einem der Ansprüche 9 bis 13 durchzuführen.

Revendications

1. Système médical comprenant :

un ou plusieurs systèmes de réseau local de corps médical, MBAN, (10), chaque système MBAN (10) comprenant :

un ou plusieurs dispositifs MBAN (12) configurés pour acquérir et communiquer des données de patient avec un dispositif concentrateur (16) par le biais d'une communication sans fil à courte portée, la communication des données de patient par le biais de la communication sans fil à courte portée étant dans un spectre prédéfini, une partie du spectre prédéfini étant utilisée par un utilisateur principal et indisponible pour l'utilisation ;
le dispositif concentrateur (16) configuré pour recevoir des données de patient communiquées à partir de l'un ou plusieurs dispositifs MBAN (12) et pour communiquer avec une station de surveillance centrale (34) par le biais d'une communication à plus longue portée ;
un régulateur de canaux (44) configuré pour interdire à l'un ou plusieurs dispositifs MBAN (12) d'utiliser au moins une portion du spectre prédéfini et pour définir un schéma de découpage en canaux avec un ou plusieurs canaux du spectre prédéfini accessibles à l'un ou plusieurs dispositifs MBAN (12),
dans lequel le schéma de découpage en canaux définit un ou plusieurs canaux sans chevauchement dans le spectre prédéfini qui sont accessibles seulement à l'intérieur d'un établissement de santé et un ou plusieurs canaux se chevauchant dans le spectre prédéfini qui sont accessibles n'importe où.

2. Système médical selon la revendication 1, dans lequel le régulateur de canaux (44) est configuré pour générer des règles d'utilisation de canaux du spectre prédéfini pour l'un ou plusieurs dispositifs MBAN (12) en fonction d'une autorisation de spectre reçue et d'une utilisation surveillée du spectre prédéfini.

3. Système médical selon la revendication 2, dans lequel les règles d'utilisation de canaux désactivent l'un ou plusieurs dispositifs MBAN (12) pour la transmission sur un ou plusieurs canaux dans le spectre prédéfini.

4. Système médical selon l'une ou l'autre des revendications 2 et 3, dans lequel le régulateur de canaux (44) comprend :

une interface (50) configurée pour permettre une personnalisation des règles d'utilisation de canaux.

5. Système médical selon l'une quelconque des revendications 1 à 4, dans lequel le régulateur de canaux (44) est configuré pour définir le schéma de découpage en canaux pour maximiser un nombre de canaux dans une ou plusieurs portions du spectre non utilisées par l'utilisateur principal.

6. Système médical selon l'une quelconque des revendications 1 à 5, dans lequel le régulateur de canaux (44) est configuré pour définir un schéma de découpage en canaux avec un ou plusieurs canaux se chevauchant dans le spectre prédéfini pour optimiser l'utilisation d'une ou plusieurs portions disponibles du spectre prédéfini.

7. Système médical selon la revendication 6, dans lequel un paramètre MAC est défini pour activer ou désactiver dynamiquement l'accès à chaque canal défini.

8. Système médical selon l'une quelconque des revendications 1 à 7, dans lequel l'un ou plusieurs dispositifs MBAN (12) sont configurés pour fonctionner à une puissance suffisamment basse à laquelle la communication sans fil à courte portée est limitée dans un établissement médical et dans lequel le régulateur de canaux (44) est configuré pour définir un schéma de découpage en canaux personnalisé pour son établissement médical.

9. Procédé comprenant :

la collecte de données de patient par un ou plusieurs dispositifs de réseau local de corps médical, MBAN, (12) ;
l'interdiction, par un régulateur de canaux, à l'un ou plusieurs dispositifs MBAN (12) d'utiliser au moins une portion d'un spectre prédéfini, une partie du spectre prédéfini étant utilisée par un utilisateur principal et indisponible pour l'utilisation ;
la définition, par le régulateur de canaux, d'un schéma de découpage en canaux avec un ou plusieurs canaux du spectre prédéfini accessibles à l'un ou plusieurs dispositifs MBAN (12), dans lequel le schéma de découpage en canaux définit un ou plusieurs canaux sans chevauchement dans le spectre prédéfini qui sont accessibles seulement à l'intérieur d'un établissement de santé et un ou plusieurs canaux se chevauchant dans le spectre prédéfini qui sont accessibles n'importe où ;

la communication des données de patient collectées de l'un ou plusieurs dispositifs MBAN (12) par l'intermédiaire d'un système MBAN (10) à un dispositif concentrateur (16) par le biais d'une communication sans fil à courte portée, la communication sans fil à courte portée étant dans le spectre prédéfini ; et
la communication des données de patient collectées du dispositif concentrateur (16) à une station de surveillance centrale (34) par le biais d'une communication sans fil à plus longue portée.

10. Procédé selon la revendication 9, comprenant en outre :

la génération de règles d'utilisation de canal du spectre prédéfini pour l'un ou plusieurs dispositifs MBAN (12) en fonction d'une utilisation surveillée du spectre prédéfini.

11. Procédé selon la revendication 10, comprenant en outre :

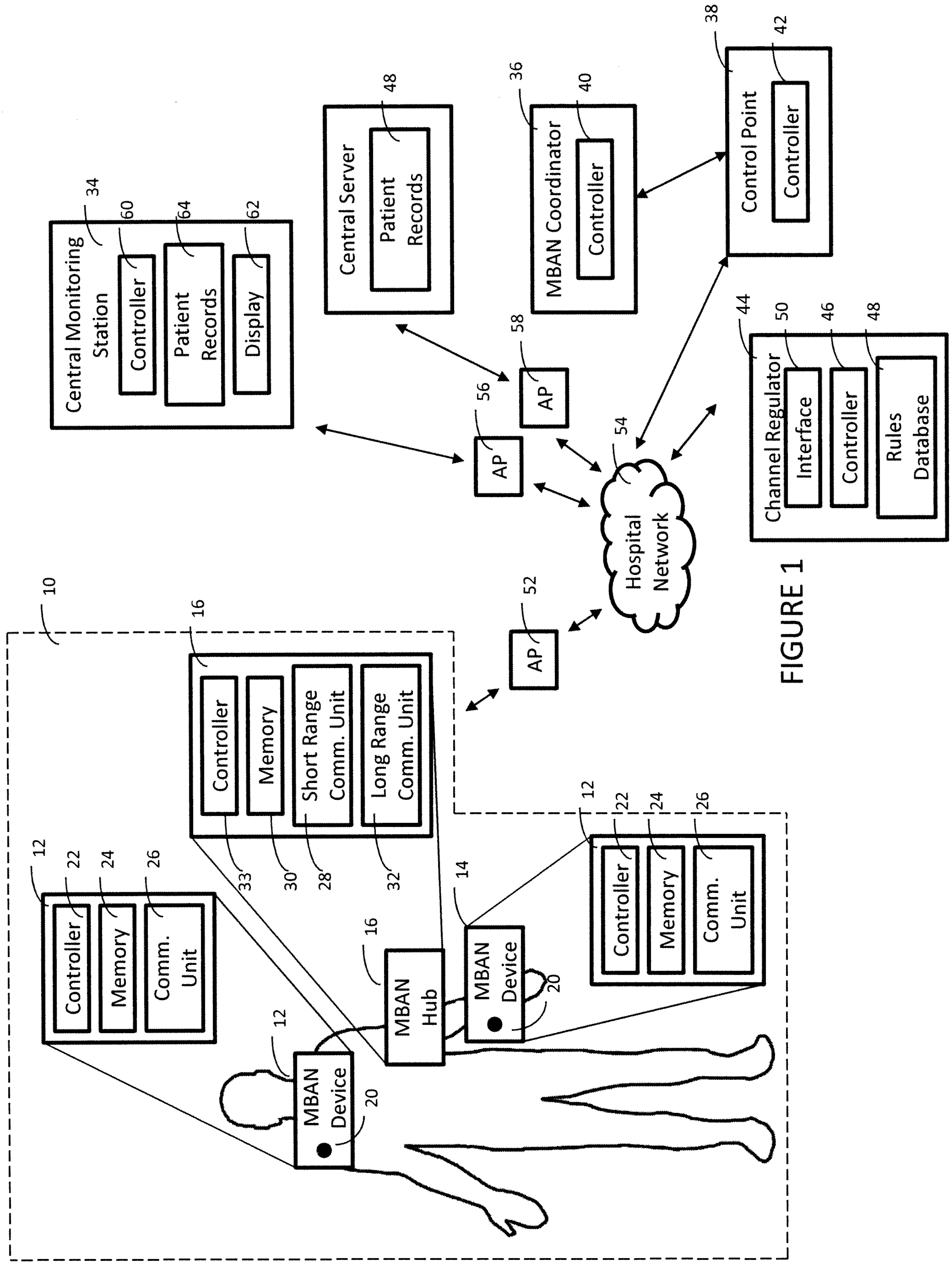
la désactivation de l'un ou plusieurs dispositifs MBAN (12) pour la transmission sur un ou plusieurs canaux dans le spectre prédéfini en fonction des règles d'utilisation de canaux.

12. Procédé selon l'une quelconque des revendications 9 à 11, dans lequel
le schéma de découpage en canaux maximise un nombre de canaux dans une ou plusieurs portions du spectre non utilisées par l'utilisateur principal.

13. Procédé selon l'une quelconque des revendications 9 à 12, comprenant en outre :

la définition d'un schéma de découpage en canaux personnalisé pour d'autres établissements médicaux avec un ou plusieurs canaux se chevauchant dans le spectre prédéfini pour optimiser l'utilisation d'une ou plusieurs portions disponibles du spectre prédéfini.

14. Support lisible par ordinateur contenant un logiciel qui, quand il est chargé dans un processeur, programme le processeur pour effectuer le procédé selon l'une quelconque des revendications 9 à 13.



Central Monitoring Station
Controller
Patient Records
Display
Central Server
Patient Records
MBAN Coordinator
Controller
Control Point
Controller
Channel Regulator
Interface
Controller
Rules Database
AP
AP
AP
Hospital Network
Controller
Memory
Short Range Comm. Unit
Long Range Comm. Unit
Controller
Memory
Comm. Unit
Controller
Memory
Comm. Unit
MBAN Hub
MBAN Device
MBAN Device
10
12
14
16
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FIGURE 1

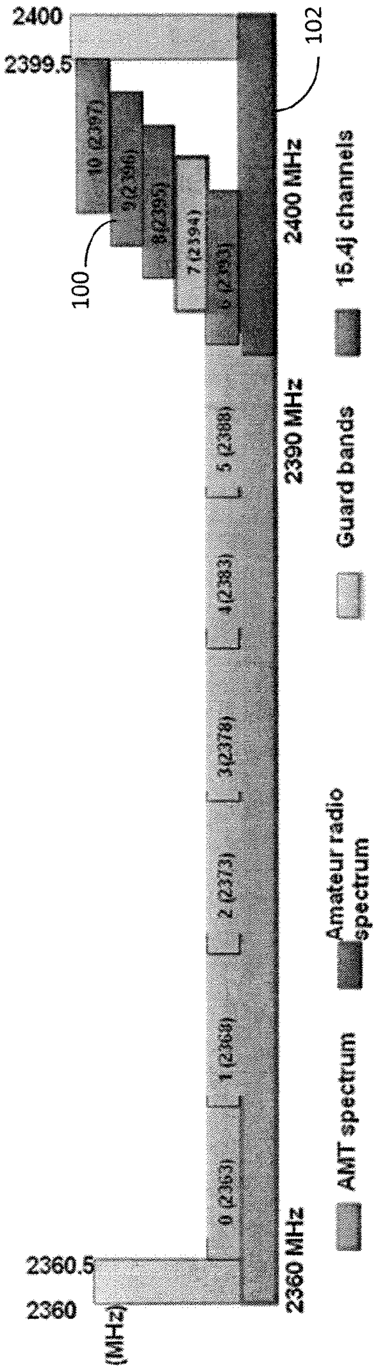

FIGURE 2

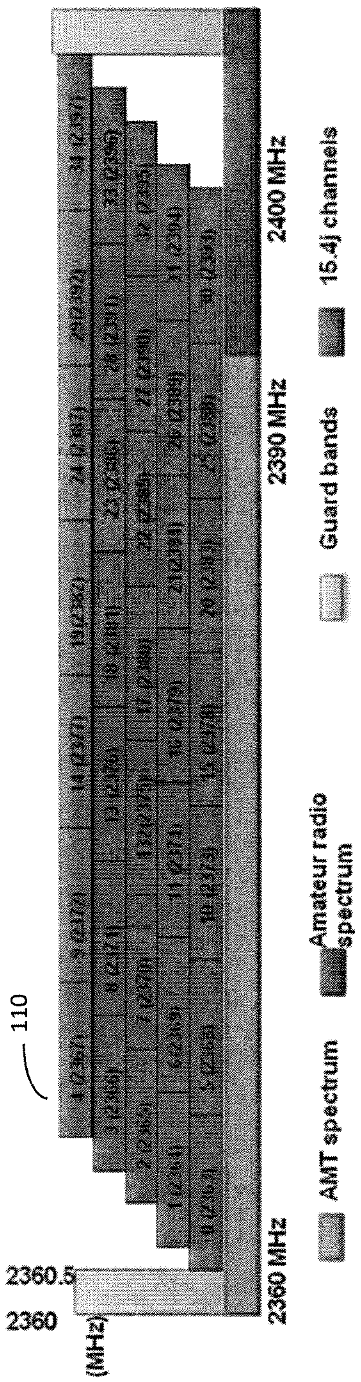

FIGURE 3

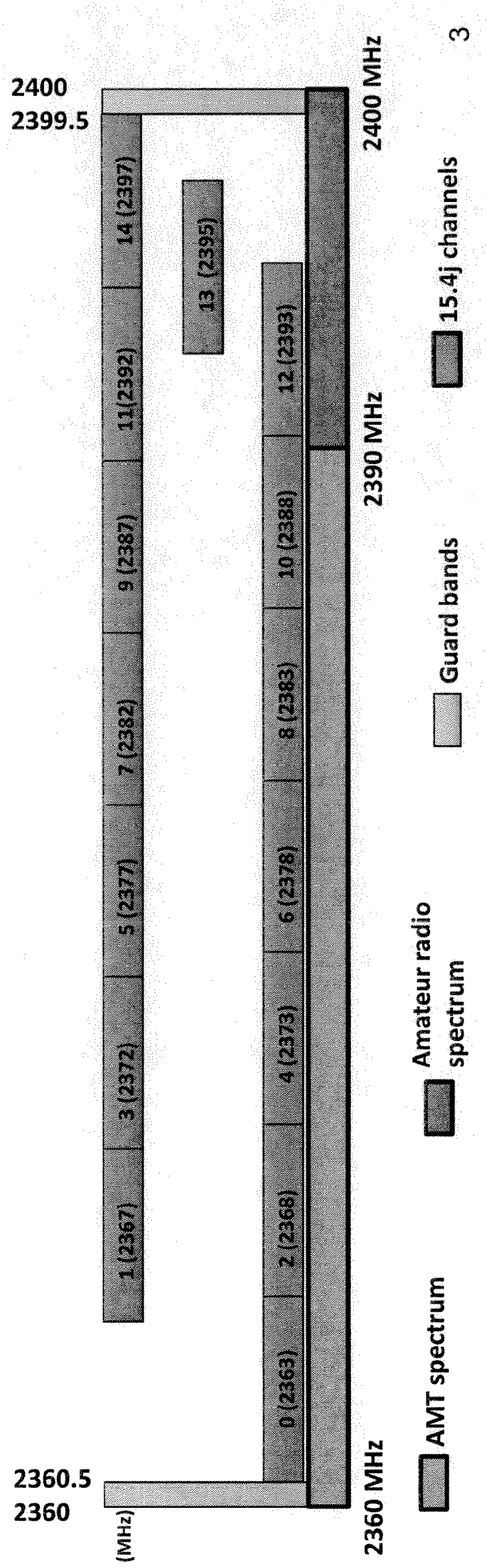
2400
2399.5
14 (2397)
11(2392)
9 (2387)
7 (2382)
5 (2377)
3 (2372)
1 (2367)
13 (2395)
12 (2393)
10 (2388)
8 (2383)
6 (2378)
4 (2373)
2 (2368)
0 (2363)
2360.5
2360
(MHz)
2400 MHz
2390 MHz
2360 MHz
AMT spectrum
Amateur radio spectrum
Guard bands
15.4j channels
3

FIGURE 4

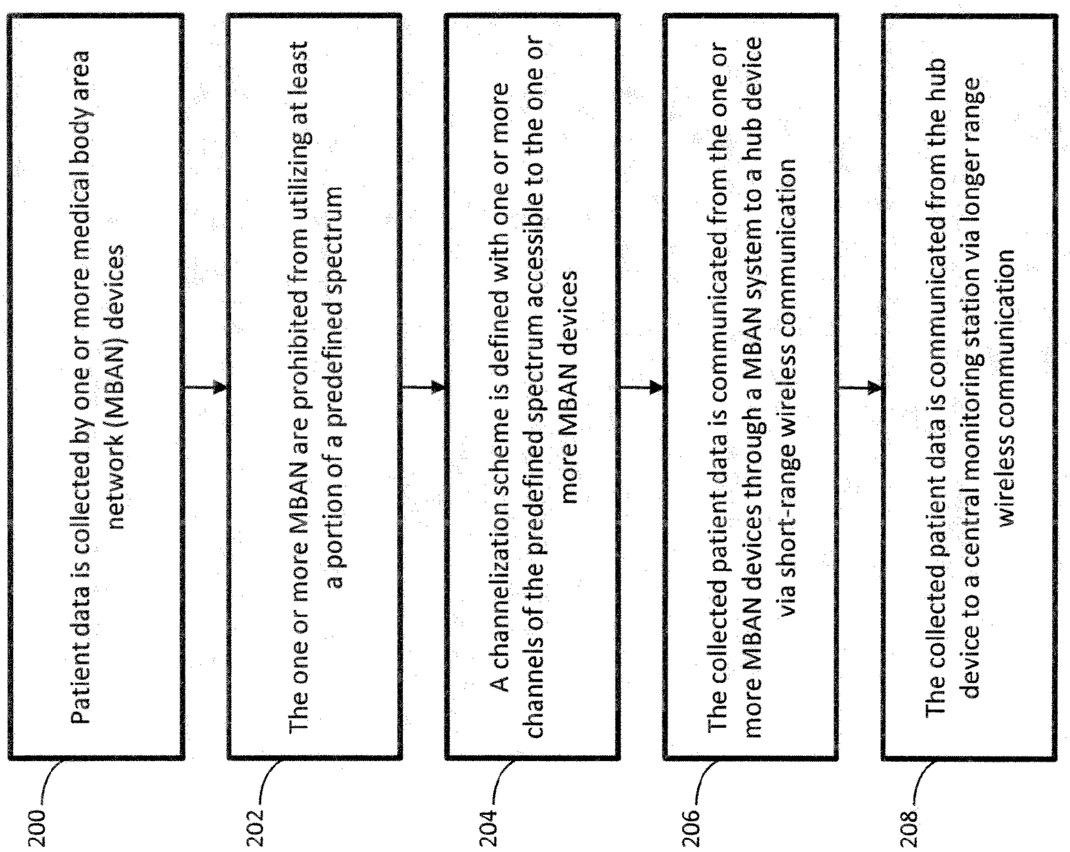
200
Patient data is collected by one or more medical body area network (MBAN) devices
202
The one or more MBAN are prohibited from utilizing at least a portion of a predefined spectrum
204
A channelization scheme is defined with one or more channels of the predefined spectrum accessible to the one or more MBAN devices
206
The collected patient data is communicated from the one or more MBAN devices through a MBAN system to a hub device via short-range wireless communication
208
The collected patient data is communicated from the hub device to a central monitoring station via longer range wireless communication

FIGURE 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2006102538 A2 **[0009]**

Non-patent literature cited in the description

- Emerging cognitive radio applications: A survey. **JIANFENG WANG et al.** Communications Magazine. IEEE, 2011, vol. 49 **[0010]**

专利名称(译)	IEEE 802.15.4j标准化的mban信道使用调节方案和自适应信道化		
公开(公告)号	EP2705682A1	公开(公告)日	2014-03-12
申请号	EP2012722544	申请日	2012-04-27
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
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IPC分类号	H04W16/14 A61B5/00 H04W84/18 A61B5/0205 A61B5/024 A61B5/0402 A61B5/08 A61B5/145 G06F19/00 H04W4/00 H04W72/04		
CPC分类号	A61B5/002 A61B5/0024 A61B5/02055 A61B5/024 A61B5/0402 A61B5/0816 A61B5/14532 A61B5/4839 G06F19/3418 G16H40/67 H04W4/80 H04W16/14 H04W84/18 H04W72/0493		
代理机构(译)	STEFFEN , THOMAS		
优先权	61/481441 2011-05-02 US 61/578476 2011-12-21 US		
其他公开文献	EP2705682B1		
外部链接	Espacenet		

摘要(译)

医疗系统包括一个或多个医疗体域网（MBAN）系统。每个MBAN系统包括一个或多个MBAN设备，其通过短距离无线通信与集线器设备获取并传送患者数据。经由短程无线通信的患者数据的通信在预定义的频谱内。集线器设备接收从一个或多个MBAN设备传送的患者数据，并通过较长距离通信与中央监控站通信。 MBAN信道化方案定义预定义频谱中的一个或多个重叠信道，并且MAC参数动态地启用或禁用对每个定义的信道的访问。信道调节器通过设置MAC参数来管理预定义频谱的MBAN利用率，以动态地启用/禁用预定义频谱内的一个或多个预定义MBAN信道。