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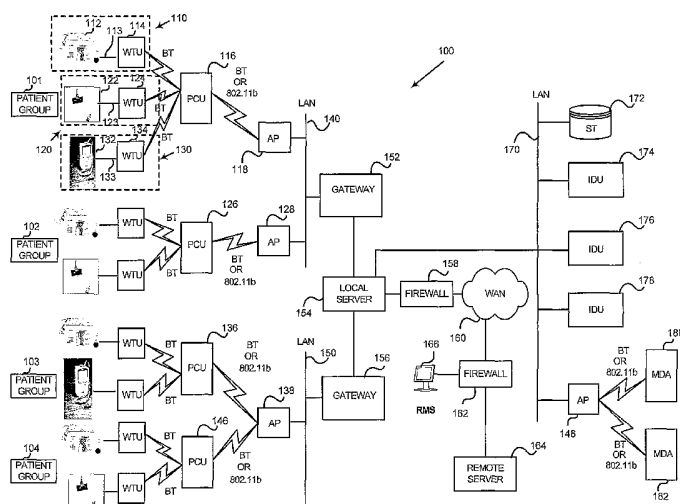
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(54) Title: PERSONALIZED REMOTE PATIENT MONITORING SYSTEMS AND METHODS



(57) Abstract: This invention describes a system running a Sensitron Personalization Protocol (SPP) for automated, efficient, or cost effective remote medical monitoring of patients located in hospitals, healthcare institutions or homes. The system is a modular and automated system, scalable to support very large number of users reliably, wireless enabled medical monitors with two way communication between server for real time data transfer, which improves the quality of care, fully automated data collection methodology including the ability to gather data from any medical device with digital data output, communicating with varied protocols, to verify the data validity or accuracy, insuring data security or confidentiality during data transmission or storage, or a central server to review the data or make decision in real time including network diagnostic abilities to check the system functionality, data storage with full back up provision or finally, or monitoring stations (wired or wireless) to review patient data.

PERSONALIZED REMOTE PATIENT MONITORING SYSTEMS AND METHODS

BACKGROUND

5 The present invention relates to personalized remote patient monitoring systems or methods with a protocol that monitors or interacts with multiple patients in real time in a medical environment.

Remote patient monitoring has shown to reduce the cost of medical care in numerous controlled studies. This technology has enabled the medical care provider faster
10 access to the patient vital sign data or in certain environments; it provides real time interaction between the care provider or the patient remotely using video equipment. In most of the academic studies, the remote monitoring has been conducted on a limited patient population with extremely expensive equipment custom designed for the study which is not economically viable for the regular usage. Monitoring of patients in a health
15 care institution such as hospitals on an automated basis is performed in selected parts of the hospital such as the emergency unit or the intensive care unit, where a few beds are fully wired or health care workers are dedicated to monitoring the output of the instruments continuously. The majority of the hospital beds have entirely manual system for gathering the vital signs of the patients at discrete intervals, or storing them in paper
20 records, with manual entry into a computer using a keyboard. This method of gathering patient data has continued over the years with little change.

SUMMARY OF INVENTION

25 This invention describes a system or a method running a personalized remote patient monitoring system (also known as a Sensitron System) on a protocol known as a Sensitron Personalization Protocol (SPP). The Sensitron Personalization Protocol provides efficient, cost effective remote medical monitoring of patients located in a hospital or an appropriate healthcare institution or in homes. The Sensitron System is a
30 scalable system capable of supporting a large number of users providing wireless enabled medical monitors with two way communication between healthcare workers, patients and healthcare providers themselves. The features include allowing fully automated data

collection methodology to gather data from a wide range of devices communicating with varied protocols; verifying the data validity or accuracy; insuring data security or confidentiality during data collection or transmission; a central local server to review the data or make decision in real time including network diagnostic abilities to check the system functionality for a very large number of users; a data storage with full back up provision or finally, monitoring stations (wired or wireless) to review patient data. The protocol makes the system modular so that it can support increasing number of monitoring or other devices without any changes in the hardware or the software set up. It insures plug-and-play functionality to provide a complete solution. The additional functionality in the system is brought about without adding to the cost of the system significantly.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a personalized remote patient monitoring system implementing Sensitron Personalization Protocol in a hospital with a central local server coupled over the Local Area Networks or a Wide Area Network.

Figure 2 illustrates patients with dedicated Patient Units monitored by a personalized remote patient monitoring system implementing Sensitron Personalization Protocol.

Figure 3 shows a Patient Unit formed by coupling a Wireless Transmission Unit to an instrument externally or internally.

Figure 4 is a block diagram of a personalized remote patient monitoring system implementing Sensitron Personalization Protocol.

Figure 5 is a block diagram of a personalized remote patient monitoring system implementing Sensitron Personalization Protocol with separate local or remote server coupled over.

Figure 6 shows the relative level of alarms for vital sign parameters.

Figure 7 shows the flow of information of a personalized remote patient monitoring system implementing Sensitron Personalization Protocol.

DETAILED DESCRIPTION OF THE FIGURES

The following description includes the best mode of carrying out the invention, illustrates the principles of the invention or should not be taken in a limiting sense. The scope of the invention is determined by reference to the claims. Each part or step is
 5 assigned its own number in the specification or drawings.

Figure 1 shows a personalized remote patient monitoring system 100 implementing Sensitron Personalization Protocol (SPP) in a health care network environment such as in a hospital. The system 100 runs on a network including wired or wireless network protocols, communicating to a plurality of devices to be described to
 10 implement patient care or to exchange vital data through the system 100 using Sensitron Personalization Protocol. A local server 154 is coupled over the Local Area Networks 140, 150 or 170 (LAN) or a Wide Area Network (WAN) 160. This figure depicts multiple patient groups 101, 102, 103 or 104. A patient group such as patient group 101 may consist of one or more patients. Individually a patient may be monitored by one or more
 15 Patient Units (PU) 110, 120 or 130. For brevity, Patient Unit 110 is shown a one to one correspondence between an instrument 112 coupled through a cable 113 to a Wireless Transmission Unit (WTU) 114. Patient Units 120 or 130 are respectively formed by instruments 122 or 132 coupled through cables 123 or 133 to Wireless Transmission Units 124 or 134. In various embodiments, instruments 112, 122 or 132 are medical
 20 monitoring instruments, actuators, environmental monitors or a combination of any of the above instruments supported by the Sensitron Personalization Protocol. A partial list of medical monitoring instruments is given in table 1.

Table 1. List of medical monitoring instruments supported by SPP

Blood Pressure Monitors, including pulse rate measurement
Heart rate monitors
Body temperature monitors
Blood oxygen saturation monitors
Blood sugar monitors
Electrocardiogram

Spiro meters
Weight scale (Embedded in the bed or floor model)
EEG

In addition, various actuators or robotics instrument handlers such as flow control meters for the drip ivy, or the flow controller of oxygen being inhaled by a patient are also controlled by the Sensitron Personalization Protocol.

A partial list of actuators supported by SPP is given in table 2.

5

Table 2. List of actuators supported by Sensitron System running SPP

Drip IV pump control valve
Gas flow meters
Implanted drug release pumps
Medical robotics devices
Internal feeding pumps

Table 3. shows a partial list of environmental monitors supported by SPP equipped to gather environmental data.

Room temperature monitors
Particle counters
Hygrometers or humidity monitors

10

The instruments 112, 122, 132 measure the vital signs of a patient or generate data in digital format or transmit through the output port terminals through cables 113, 123 or 133 coupling to the connectors (not shown) on Wireless Transmission Units 114, 124 or 134.

15 The preferred instrument data output format complies with standards known as RS 232, RS 485, universal serial bus (USB1.0 or USB2.0) standard, or parallel data output

including IEEE488, Medical Information Bus or any similar data formatting standard. Even within the data output standard RS232, there are a number of variations of the data format from the equipment available currently which enforces the need for matching data transfer method on the receiving end, or further processing of the data stream to extract
5 actual data. If the instrument is an actuator, data is input into the actuator through a cable or the actuator status is monitored over the data bus.

In an embodiment, a Wireless Transmission Unit having multiple data ports can support several instruments simultaneously. A cluster of Patient Units 110, 120 or 130 is served by a single Patient Communication Unit 116 monitoring various patients in the
10 patient group 101. Similarly, patient groups 102, 103 or 104 are served through Patient Communication Units 126, 136 or 146. Multiple patient groups are served from one or more Patient Units, a mobile Patient Unit with instruments on a trolley may be deployed for ease of operation. In an alternate embodiment of the invention, a Wireless Transmission Unit is used to support only a single instrument as a part of a Patient Unit.
15 Thus, a single Patient Unit comprises of one or more instruments with each instrument coupled to a dedicated Wireless Transmission Unit. The population of instruments (see Tables 1 to 3) in a Patient Unit is flexible or it can vary from one Patient Unit to another. The Patient Unit 110 may consist of a blood pressure meter only, while Patient Unit 120 may consist of a blood pressure meter, oxygen saturation meter, or a thermometer, while
20 Patient Unit 130 may consist of an oxygen saturation meter or a drug infusion pump.

The Patient Communication Units 116, 126, 136 or 146 exchange data with the access points 118, 128 or 138 that are coupled to the local area networks (LAN) 140 or 150 in the hospital. A single access point 138 can support multiple Patient Communication Units 136 or 146. Patient Units 110, 120 or 130 communicate with
25 Patient Communication Unit 116 using Bluetooth wireless protocol (BT). Patient Communication Unit 116 extracts the data from the communication received from the Patient Units 110, 120 or 130 over Bluetooth link, then aggregates the data in a single data stream or formats it according to the 802.11b Ethernet data format or then retransmits the formatted data to access point 118. A Patient Communication Unit has the
30 option to encrypt the data prior to coding it for wireless transmission. The wireless link used to link the Patient Units to the Patient Communication Units or to the access points uses a combination of two different wireless protocols, namely Bluetooth or 802.11b protocol with or without order of sequence. In an alternate embodiment, both the wireless

links use Bluetooth protocol. In yet another embodiment, both the wireless links use 802.11b protocol. This invention covers all the existing wireless protocols to support the bidirectional wireless links between the instruments in the Patient Units or the access points such as Zigbee or (ultra wideband) UWB. Multiple access points are coupled to one or more local area networks in the hospital that are configured as various domains coupled to one or more gateway servers such as gateway servers 152 or 156. Gateway servers 152 or 156 routes the data packets to a local server 154 such as a Sensitron Central Server supported by a suitable data storage unit 172. Gateways 152 or 156 polls all the Patient Communication Units 116, 126, 136 or 146 at regular interval to check their status, wherein any non performing Patient Communication Units are reported to the maintenance organization. Gateway 152 or 156 reads the battery voltage of every network node such as Patient Unit 110 or Patient Communication Unit 116 during monitoring or reports any violation or degradation to the maintenance organization.

The server 154 or the storage unit 172 operate with appropriate back up units to provide fault tolerant operation with availability greater than 99.999% of the time as an option. The information generated at the server 154 is displayed at the display units (IDU) 174, 176 or 178 inside the hospital. Multiple mobile display units (MDA) 180 or 182 are coupled to the Local Area Network 170 through one of the existing access point 148.

Through a firewall 158, the local server 154 is coupled to the Wide Area Network 160. On the other side of the Wide Area Network 160, through another firewall 162, the network feeds in to a remote server 164 that duplicates the vital function or data storage of the local server 154. A partial list of services to the Wide Area Network 160 include dial up access, DSL access, Cable modem access, wireless access point, cellular network, fiber optics network, MMDS, LMDS or VSAT etc. The information from the local server 154 can also be displayed at a remote monitoring station (RMS) 166. The remote monitoring station 166 can exist inside the home of a physician, or any other authorized health care worker. Secure communication across the Wide Area Network 160 is provided using any of the existing technologies, including virtual private networks, as is known to those skilled in the art. Remote monitoring station 166 can also be a cell phone, a wired or wireless PDA, a pager, a lap top computer or personal computer coupled to the Wide Area Network 160 that can receive messages.

Figure 2 shows an alternate embodiment of the Sensitron Personalization Protocol system 200 where an individual patient 210 has a dedicated set of Patient Units 212, 222,

232 or 242. In this embodiment, each Patient Unit is an instrument with a Wireless Transmission Unit internally coupled (see Figure 3) communicating to a Patient Communication Unit 216 or monitored by personalized remote patient monitoring system implementing Sensitron Personalization Protocol. The actual configuration by the patient bed side may vary or include additional or fewer patient monitors, actuators, or other devices. The patient data is transmitted wirelessly to an access point 218 that is coupled to a hospital Local Area Network 240. The patient 210 is monitored by local monitoring stations LMS 246 or LMS 248. This figure illustrates the Sensitron Personalization Protocol system 200 is adapted in its design to take all the data for the patient bedside to a single hospital local server 230 without the need for a Wide Area Network 250 coupling or connection. However, remote monitoring with a remote monitoring station RMS 256 or a remote server 260 running Sensitron Personalization Protocol by coupling over a Wide Area Network 250 is supported by this Sensitron Personalization Protocol system 200.

15 The Patient Communication Unit 216 comprises of a microcomputer with a suitable display or built-in hardware or software to couple to the Wireless Transmission Units in the Patient Unit 212 wirelessly, or also to the local area network 240 of the hospital wirelessly. Patient Communication Unit 216 can use different wireless protocols to couple to the two units. For instance, the Patient Communication Unit 216 can use Bluetooth to communicate with a Wireless Transmission Unit in Patient Unit 212, or use 20 802.11b to communicate with the local area network 240 through access point 218. In the preferred embodiment of this invention, the Patient Communication Unit 216 is a portable microcomputer powered by batteries such as a "Personal Digital Assistant" (PDA), a tablet, or a notebook computer. A desktop computer can also be used for this purpose.

25 Each Patient Communication Unit has a unique mac address programmed at the factory which can not be changed without destroying the Patient Communication Unit. The Sensitron Personalization Protocol system 200 assigns a single Patient Communication Unit to every patient. While admitting the patient 210 in the health care institution, a Patient Communication Unit 216 is assigned to the patient 210 or the ID of the Patient

30 Communication Unit 216 is correlated with the ID of the patient 210 (also known as patient ID) and this information is stored in the local server 230 running Sensitron Personalization Protocol also known as the Sensitron server. In an alternate embodiment, multiple patients are supported by a single Patient Communication Unit and appropriate

methods are used to identify each patient at the point of use such as picking a name from a drop down menu on the Patient Communication Unit, reading the ID of the patient from a bar code contained in the wrist band of the patient, or an RFID tag contained in the wrist band of the patient. The Patient Communication Unit 216 is programmed to contain instructions for monitoring of the patient 210 or a list of specific instruments to be used for the patient 210. Alternatively, this invention also includes a display screen on the Patient Communication Unit 216 to select the types of monitors from a list to be used for the patient 210. Each Patient Communication Unit is designed to support multiple Wireless Transmission Units, limited by the communication protocol operating between the wireless transceivers (shown in Figure 4) in the Wireless Transmission Units and the Patient Communication Unit. For example, the Bluetooth standard allows up to 255 devices to be addressed by a master, but can only support 7 of the devices active at any time. Hence, Sensitron Personalization Protocol using Bluetooth supports 255 Wireless Transmission Units from each Patient Communication Unit, with only 7 Patient Communication Units active at any one point of time. This limits the numbers of Patient Units supported by a Patient Communication Unit to 255 since the Patient Communication Unit addresses the Patient Units serially, with 7 Patient Units being active at any point of time. (The exact number of patients supported by a single Patient Communication Unit will vary, depending upon the number of Patient Unit associated with each patient such as patient 210.) The maximum number of active devices at any one point of time will vary in case the communication is based on 802.11b standard, as is known to those skilled in the art.

In the preferred implementation of the Sensitron system, a PDA, a tablet computer or a notebook with Bluetooth or 802.11b hardware or software is used as a Patient Communication Unit 216. The Patient Communication Unit 216 contains a wireless transceiver which receives the communication from Wireless Transmission Unit, or decodes the data stream from the RF signal. The Patient Communication Unit 216 is pre-programmed with the mac address, or equivalent unit identifier (Bluetooth address) of the Wireless Transmission Unit units which it is expected to communicate with. This function is built-in to insure that unintended data communication between a Patient Communication Unit 216 and a Wireless Transmission Unit is not possible. Patient Communication Unit 216 establishes communication with the intended Wireless Transmission Unit only, or then it exchanges commands or data with the Wireless

Transmission Unit. In an alternate embodiment of the invention, the Bluetooth radio in the Patient Communication Unit 216 is programmed to discover all other Bluetooth radios or transceivers in the vicinity at the beginning of the monitoring session. Bluetooth radios discovered by Patient Communication Unit 216 contain the intended Wireless

5 Transmission Units 212, 222, 232, 242 among others. All the discovered Bluetooth radios are presented on a screen represented by the Patient Units supported by them to the health care worker doing the monitoring, or they are asked to select the Patient Units to be used for monitoring the patient. Based upon the input, a secure coupling is established between the Patient Communication Unit and the Patient Units. Data from any other Patient Unit

10 is rejected by the Patient Communication Unit for the duration of that particular session.

The data is formatted in the Ethernet format prior to wireless transmission, or any other suitable protocol based format is covered by this invention. Upon receiving the data packet from the Patient Communication Unit 216, Wireless Transmission Unit in Patient Unit 212 extracts the instruction from the data or takes appropriate action. It implies the

15 following;

1. Identifying the medical equipment attached to the Wireless Transmission Unit.
 2. Sending a command to the instrument to initiate measurement.
 3. Gathering the data output from the instrument, formatting the data in Sensitron Personalization Protocol as described above, or sending it back to the Patient
- 20 Communication Unit.

The data from the Wireless Transmission Unit is decrypted first or the relevant fields are extracted from the payload. The Patient Communication Unit 216 performs certain checks on the data, such as identifying the error bits or in case of an error, the Patient Unit 212 takes the appropriate corrective action; comparing the data with the safe

25 operating limits of the instrument, or in case of violation of these limits, requesting the Patient Unit to 212 repeat the measurement. An audio-visual-text based alarm system is also deployed to present the instructions or the error messages to the user performing the measurements. Certain checks are also conducted at the Patient Communication Unit 216 to check the validity of the data or local alarms are raised in case error conditions are

30 detected. At the completion of these checks, the data from all the patient units aggregated in the Patient Communication Unit 216, or it is formatted according to Sensitron Personalization Protocol. The payload is encrypted, or the data is transferred on to the

wireless module for transmission of the data from the Patient Communication Unit 216 to the access point 218 or the base station. In the preferred embodiment of the invention, the data is transferred using wireless networking protocol, such as 802.11a, 802.11b, 802.11g or equivalent. The Patient Communication Unit 216 contains the required hardware or
5 software to enable the data transmission.

In the alternate embodiment of this invention, the Wireless Transmission Unit is programmed before deployment to match the data exchange protocol of the medical device that it is coupled to. For instance, the output format of the data from the serial interface of the medical device occurs at 9600 baud with 7 bits or no parity bit. The
10 interface unit of the Wireless Transmission Unit, commonly known as the UART to those skilled in the art, is programmed to operate with the exactly the same parameters as the medical device in order to exchange data with the medical device. This programming parameter is downloaded in the Wireless Transmission Unit over the wireless link, including the instructions for programming of the UART buffer to exchange data with the
15 medical device. The data exchange with the wireless unit is done with the same set of parameters. The control of data communication between the wireless transceiver and the instrument is done by the microcontroller in the Wireless Transmission Unit.

In yet another embodiment of the invention, the Wireless Transmission Unit is programmed in the field to match the data exchange protocol of the medical devices that
20 it is coupled to. This is similar to the plug-and-play functionality known to those skilled in the art. The information for programming the Wireless Transmission Unit to interface with a specific medical device is stored in a suitable location such as the PCU.

The data from the Patient Unit 212 Wireless Transmission Unit is transmitted to the Patient Communication Unit 216. In this instance, the Patient Communication Unit
25 216 is pre-programmed to work with a specific Patient Unit 212 - the Wireless Transmission Unit coupled to a specific instrument. Since the Patient Communication Unit 216 recognizes the Patient Unit 212 which is transmitting the data, Patient Communication Unit 216 uses the appropriate algorithm to extract data from the packet received from the packet. Alternately, the Wireless Transmission Unit does not contain
30 any programming information when delivered for usage for interfacing with the Patient Unit 212 which, as an example, includes a blood pressure meter manufactured by vendor XYZ, or a model number LMN. The Patient Communication Unit 216 contains a library of data specifications from various vendors or various models in the non-volatile memory

of the system. The signature of the medical device is extracted from the initial data packet delivered from Wireless Transmission Unit to the Patient Communication Unit, or it is matched with the entries in the library, or the appropriate data specification for the model LMN manufactured by vendor XYZ is retrieved from the library. This data specification is used to program the Wireless Transmission Unit to seamlessly exchange data with the medical device or transmit it over the Bluetooth wireless link to the Patient Communication Unit. Another class of mobile device configuration supported by this invention is one where the mobile clients are used only for the purposes of querying the database or accessing the data for a patient, a group of patient, or any other data set available in the server. The purpose of such a device (wired or wireless), such as a desktop computing device, a notebook, PDA or a tablet or a pager or any mobile wireless device capable of receiving text or graphical messages is to allow the qualified users to access information about certain patients remotely. This client is also called a medical device assistant (MDA) 244 for this purpose. The medical device assistant 244 operates by sending certain queries to the database, or receiving the information which is displayed for the users. The medical device assistant 244 is also used for receiving certain alerts such as those generated when the patients' vital signs have crossed the threshold set by the physicians or the care providers at the time the last set of vital signs were analyzed by the server. This medical device assistant 244 communicates directly with the access point 214 or the base station using the same wireless communication link as the Patient Communication Unit 216. A point of difference between the Patient Communication Unit 216 or the medical device assistant 244 is that the medical device assistant 244 is used only to query or retrieve information as a client from the server database, or receive alerts while the Patient Communication Unit 216 also takes on the role of a server while communicating with the Patient Unit 212 to gather data.

An access point is the next node in the network which supports full two way communication between the access point and the Patient Communication Unit. An access point refers to commercially available hardware complying with a given wireless protocol which acts as a bridge between the wireless transceivers or the wired data network, such as Ethernet, known to those skilled in the art. For instance, an access point for 802.11b wireless Local Area Network protocol is used as a base station. An access point 218 functioning as a base station exchanges data with the Patient Communication Unit 216 or supports medical device assistant 244 using appropriate wireless protocol. A single base

station is designed to support multiple Patient Communication Units or medical device assistants. Multiple Patient Communication Units are supported by the base station in a star pattern with the base station at the center. The Patient Communication Unit has to be within the range of the base station to have a wireless communication link. Base station is also coupled to the local area network of the healthcare facility. In an installation with large number of patients such as hospitals, multiple base stations are coupled to a local area network inside the hospital. Although the preferred mode of coupling to a base station or access points is wireless Local Area Network 802.11b or wired Local Area Network, any other suitable means of coupling to various access points can also be used.

10 The data from the various access points 214 or 218 is sent to a local server 230 in a hospital which performs the gateway function. The gateway is a term used in network configuration or well known to those skilled in the art. The gateway performs the network traffic management function by controlling the communication with every node on the network represented by access points or Patient Communication Units. The gateway also maintains the data communication channel with the server.

 In one embodiment of the invention, the server 230 at the hospital sends data over the Wide Area Network 250 to the server 260 for various data analysis or storage functions. In another embodiment of the invention, the server 260 or the server 230 are the same or there is no need for Wide Area Network coupling between the two. The server performs the user authentication function prior to serving data to any user. The server 260 receives the data, decrypts or separates the header information from the data. Data is added to each individual patient database or made available for further analysis. The data analysis package running on the server 260 checks the data for compliance with respect to the alarm levels or in case of violation, an alarm with the patient ID, patient location or latest data set it is made available to the nurse on duty. The nurse has the options to download additional patient data, call the doctor, forward the data to the doctor, or even call the emergency team in the hospital. The details of the algorithm (Figure 7) are described later on in this document.

 The data is also archived or stored in hard disk 262, at certain predetermined intervals, it is also backed up. Preferred back up period ranges from 6 hours to 48 hours, or back up period ranging between 1 hour and 168 hours is also included as a system feature.

For single users in homes, the Sensitron Personalization Protocol provides the access point to couple to the server 262 through various other means such as a dial up modem, a DSL modem, a cable modem, or a wireless, satellite link.

Figure 3 shows a Patient Unit 300 with a cable 306 coupling an instrument 302 to
5 an external Wireless Transmission Unit 308. The Wireless Transmission Unit 308 receives data from the instrument 302 through the cable 306 coupled to data ports 304. In an alternate embodiment of the system, the Patient Unit 310 is an instrument 312 with a Wireless Transmission Unit (not shown) coupled to the instrument 312 internally enclosed in the same enclosure. The instruments 302 or 312 include medical monitoring
10 equipment, an actuator or an environmental monitor that is listed partially in earlier description. In another embodiment (not shown), one or more instruments may be housed in the same enclosure. The Wireless Transmission Unit 308 transmits the data to a Patient Communication Unit (not shown) through a standard wireless protocol such as Bluetooth.

The output of the instrument 302 is fed to the external Wireless Transmission Unit
15 308. Wireless Transmission Unit 308 contains a microprocessor (processor) in the data processing unit (see Figure 4) which controls its communication with the instrument 302 or the internal wireless transceiver (radio). The serial data communication format of the instrument 302 is matched by the data I/O unit of the Wireless Transmission Unit 308 by storing appropriate instructions in the non-volatile memory on board the data processing
20 unit in the Wireless Transmission Unit 308. For instance, the instrument 302 may require the use of only receive or transmit pins with a baud rate of 9600 or no parity bits. This information is provided by the manufacturer of the instrument, and programmed in the Non Volatile Random Access Memory (NVRAM) on board the Wireless Transmission Unit 308 such that only receive or transmit pins are activated, or the Wireless
25 Transmission Unit 308 sends or receives data at the appropriate baud rate or does not check the parity bits of the incoming data. This programming of the Wireless Transmission Unit 308 is done through the serial ports prior to the unit being introduced in service. In an alternate embodiment of the invention, programming of Wireless Transmission Unit 308 is done through the wireless link by sending the programming
30 data or instructions for programming the UART interface 307 in the Wireless Transmission Unit 308. This capability allows a single wireless transceiver design to be used for interfacing with all the instruments. An example of the communication between the Wireless Transmission Unit 308 and the instrument 302 using the hard wired coupling

is presented here. To initiate a measurement, the Wireless Transmission Unit 308 sends the appropriate command to the instrument 302 to get ready for taking the measurement; instrument 302 sends an acknowledgement that it is ready to take measurements; Wireless Transmission Unit 308 sends another command to the instrument 302 to initiate the
5 measurement; instrument 302 sends an acknowledgement that the measurement has been completed, or it is going to send the data if Wireless Transmission Unit 308 is ready; instrument 302 then transfers the data, or signals the end of transmission; or cycle is completed.

After accepting the data packet from the instrument 302, it is transferred to a data
10 processing unit in Wireless Transmission Unit 308. This invention includes a method for automatic identification of the instrument by an external agent by reading the status of certain data registers. The decision to attach a Wireless Transmission Unit to a class of instrument such as a medical monitoring instrument is made prior to the utilization of the data processing unit in active monitoring process. Each instrument class with a unique
15 communication protocol is designated a certain bit pattern in Sensitron Personalization Protocol. This bit pattern is loaded in non-volatile memory coupled to a pre-defined set of I/O pins in the Wireless Transmission Unit. These pins are dedicated for identifying the monitors. A unique sequence of bits representing the instrument 302 is programmed in the dedicated register coupled to the data processing unit in Wireless Transmission Unit
20 308 through the serial port. The register may be external to the processor or internal to the processor. These bits are read directly from the dedicated set of I/O pins of the module without disturbing the state of the processor. For instance, the blood pressure meter of a specific model number LMN made by a manufacturer ABC will be represented by a bit pattern 001100. In a certain embodiment of this invention, this register is programmed
25 with the ID or the "serial number" of the medical instrument 302 to which this Wireless Transmission Unit 308 is attached. This bit pattern of the identification register can vary by any length, being as small as 1 bit or as large as 10,000 bits or the method to read them out is serial or parallel. The parallel read out of the instrument ID is possible only when the instrument ID length is small. For large ID word length, a serial method of reading
30 data is used. The number of I/O pins available for instrument identification is dependant upon the processor.

This invention also covers alternate methods to identify the instrument 302, such as tying certain external I/O pins on the RS232 or similar connector to ground or power

supply using external means such as a cable. This cable 306 can also contain the wires used for data transfer between the instrument 302 or Wireless Transmission Unit 308. A separate cable is needed in this implementation for every type of instrument. The status of the I/O pins, namely high or low, represents the ID of the instrument 302 linked to the
5 Wireless Transmission Unit 308. Sufficient number of pins on the cable connector are required to cover the various class of instrument which is uniquely identified by the system. A set of 3 pins will uniquely identify 8 instrument classes or a set of 5 pins will identify 32 instrument classes uniquely.

After accepting the data from the instrument 302, the processor transfers the data
10 to the data processing unit in Wireless Transmission Unit 308. The processor also reads the status of the ID register which identifies the instrument to the processor. The processor has access to an instrument driver library (shown in Figure 4) containing the data format of various instruments or medical devices, indexed by the device type which is stored in the on-board non-volatile memory. For every unique monitor class, a
15 corresponding data format set is downloaded or stored in the Wireless Transmission Unit or is used to program the data interface of the Wireless Transmission Unit. The processor matches the instrument ID with the entries in the instrument driver library, or accesses the correct data format for the given device. It uses the data format information to extract the required fields from the data stream or stores them in the temporary memory. The
20 processor also checks for any control signals or flags which may be sent with the data packet by the instrument. For example, a data packet may be sent with the error flag turned on to signify that this data is in error. If an error flag is set high, then the Wireless Transmission Unit 308 sends the data out with the error flag high. In an alternate embodiment of the invention, Wireless Transmission Unit 308 turns on an indicator to
25 signify the error condition, or requests a repeat of the measurement from the instrument 302. The Wireless Transmission Unit 308 formats the data in a Sensitron Personalization Protocol standard format. The details of data format in this protocol are described later in this document. Next, the data is converted as Ethernet data packets in the Wireless Transmission Unit 308. The source data address is the mac address of the Wireless
30 Transmission Unit 308, or the destination is the mac address of the Patient Communication Unit. The scope of this invention covers any other suitable protocol for data formatting prior to being transported to the Patient Communication Unit using short range radio link.

Figure 4 shows the block diagram of a system 400 depicting an embodiment of a personalized remote patient monitoring running the Sensitron Personalization Protocol. The system 400 contains a Patient Unit 410, a Patient Communication Unit 420, an Access Point 430, a Local Server or Gateway 440, a Remote Server 450, a Mobile Display unit 490, or a hardwired Display Unit 480. The communication between each of the units is either wireless or wired. Between the Patient Unit 410 or the Patient Communication Unit 420 the preferred mode of communication is using Bluetooth RF protocol, between the Patient Communication Unit 420 or the Access Point 430, the preferred mode of communication is wireless using wireless networking protocol 802.11b, 802.11a, or 802.11g or between Access Point 430 or the Local Server or Gateway 440; both the wireless or wired modes of communication using Local Area Network 470 are supported. Between Patient Unit 410 and Patient Communication Unit 420, or between Patient Communication Unit 420 or Access Point 430, or Access Point 430 or Local Area Network 470, any other suitable means of wireless communication such as the one listed above, plus zigbee or 802.15, or ultra-wide band communication standard is used. Between the Local Server/Gateway 440 and the Remote Server 450, the communication is over a secure Wide Area Network 460 including but not limited to wired, wireless, or optical cable coupling or connection.

The Patient Unit 410 includes one or more instrument(s) 411 such as a medical monitoring instrument, an actuator or an environment monitor, or a Wireless Transmission Unit 413 with a cable 412 hardwired coupling to the output port of the instrument 411. The preferred I/O interface 415 with a RS 232 driver between the instrument 411 I/O pins or the Wireless Transmission Unit 413 is RS232 serial data interface. The output of the RS232 driver in the I/O interface 415 interfaces with a N-bit data processing unit 419 with non-volatile memory for analyzing the data coming out of the instrument or putting the data in standard format, or storing certain reference information such as the Patient Unit ID, with the value of N ranging from 4 to 64. The preferred embodiment of the invention includes 32-bit wide data processing unit. A wireless transceiver 417 transmits data to the Patient Communication Unit 420.

The instrument(s) 411 are stand alone devices for measuring the vital signs of the patients. The cable 412 between the instrument(s) 411 or the Wireless Transmission Unit 413 also contains specific pins tied to power or ground which is sensed by the I/O interface 415 on the Wireless Transmission Unit 413, or this information is sent to the

Local Server or Gateway 440. For example, cable 412 is a 9 pin cable. Pins 1 to 4 in cable 412 may be used to carry power, ground, transmit, or receive signals, while pins 5, 6, or 9 are tied to ground or pins 7 or 8 are tied to power. This cable 412 is configured in the factory. The status of bits as instrument ID is represented by pins {5,6,7,8,9}, namely
5 {0,0,1,1,0} is detected by the Wireless Transmission Unit 413, or it is sent to the Local Server or Gateway 440. The Local Server or Gateway 440 decodes the instrument ID based upon the data packet, or downloads the driver for the instrument 411 to the data processing unit 419 in the Wireless Transmission Unit 413. An alternate embodiment of the invention includes the instrument ID to be programmed in a non-volatile memory in
10 the Wireless Transmission Unit 413 prior to its deployment. This instrument ID is read by the Patient Communication Unit 420 every time it makes a call to the Wireless Transmission Unit 413 to initiate a reading. For the first time operation, this ID is used to download the driver. It is also used for upgrading the UART driver in the field in an automated manner.

15 The data processing unit 419 decodes the data stream from the instrument 411, or formats the data in a standard format. The preferred format deployed in this invention is the Ethernet data format. However, any similar data format is used for the purpose. An embodiment of the invention includes encryption of the data prior to data formatting. The formatted data is transferred to the wireless transceiver 417 for coding or transmission
20 over the radio. Preferred embodiment of the invention deploys the use of Bluetooth based chip set for wireless data transfer using serial protocol stack built in the Bluetooth profile, as is known to those skilled in the art. An audio-visual-text display is also included with the driver electronics for the display controlled by the output from the processors. A partial list of these monitoring or actuating devices has been included in table 1, 2, or 3
25 earlier.

The I/O interface 415, data processing unit 419, audio-visual alarm indicator 416, or wireless transceiver 417 are physically designed as a single separate wireless transmission unit 413. In the preferred embodiment, a Wireless Transmission Unit 413 is associated with each medical instrument. In cases where a single data port is built in an
30 instrument housing containing multiple medical instruments, one single Wireless Transmission Unit is deployed for exchanging data with the instrument. In a separate embodiment, a Wireless Transmission Unit 413 is embedded inside the instrument 411. In

yet another embodiment (not shown), multiple instruments are integrated in a single housing with a Wireless Transmission Unit 413 used to control wireless communication.

Each instrument 411 is equipped with the signal processing circuitry which accepts the signal from the respective sensors or produces a digital data output
5 representing the patient's vital sign. Similarly, each actuator is equipped with circuitry which accepts the digital control signal or processes it to convert into electrical signals to control certain actuators. These devices deploy proprietary technology or further discussion of their technology is beyond the scope of this invention disclosure. Alternate embodiments of the inventions support other similar data formats such RS485, the
10 parallel data bus, or data formatted to comply with universal serial bus standard USB1.0 or USB2.0, IEEE 488, Medical Information Bus, or other similar data transmission standards. The data from the system 400 is received by the Wireless Transmission Unit 413 over a bidirectional, hardwired coupling. To accommodate the instruments which do not have built-in two way control instruction set, the Sensitron Personalization Protocol
15 includes the control signals to initiates the test, or perform other control functions as may be necessary, using visual or audio instructions such as sound, voice commands, lights on or off state, light flashes, text messages, graphics or symbols presented to the user as audio or visual alarm indicator(s) 416. Similar functions are also found in the audio or visual alarm indicator(s) 426 in the Patient Communication Unit 420.

20 The data from the instrument 411 is input to the data processing unit 419 which consists of a microprocessor running a real time operating system or having an external clock or local memory 414 to contain instructions as well as store measurement data. In another implementation of Sensitron Personalization Protocol, the data processing unit 419 in the Wireless Transmission Unit 413 supports multiple instrument(s) 411 through a
25 single data port.

The data processing unit 419 compares the measured patient data against preset limits for the monitoring instrument(s) 411. These preset limits called Level 0 limits representing the limits of proper operation of the instrument(s) 411, are stored locally in a non-volatile memory in the Wireless Transmission Unit 413. Figure 6 or 7 describes the
30 detection or verification of Level 0 limits violation with alarm or instructions sent to the health care taker to take appropriate corrective actions. The data processing unit 419 also stores the last few readings, ranging between 1 and 1000,000, in a first-in-first-out in the local memory 414. This implies that after the buffer is full, the next reading read in the

- buffer causes the very first reading to be read out of the buffer. The exact numbers of readings to be stored is programmable or is limited by the available memory. For instruments generating continuous stream of data, such as electrocardiogram, the stored data are traces which are segments of incoming continuous data over a fixed time period.
- 5 These data are also stored in FIFO memory of a fixed length between 1 trace and 1000 traces, with each trace covering data gathered over 1 millisecond to 1000 seconds. These traces are also compressed prior to being stored in an alternate embodiment. In yet another embodiment, certain parameters from the trace are calculated or these parameters are stored in the in FIFO local memory 414, or also used for transfer as vital sign Level.
- 10 The local memory 414 is backed by battery power for a defined period of time such as 48 hours to preserve vital data for later recovery in case of power interrupts or other communication device failure. Similar battery power back up feature is also found in the local memory 424 in the Patient Communication Unit 420. Details of the various alarm levels are included in figure 6. The algorithms for parameterization of the data stream are
- 15 instrument specific or are beyond the scope of this discussion. The data processing unit 419 also includes a clock which is synchronized with the system clock resident in the local server 440. This clock output is utilized to annotate the data stream being sent to the wireless transceiver 417 for transmission.

- The data format of the input to the wireless transceiver 417 is shown below in
- 20 table 4.

<SensorUnit ID>	First N bits containing ID of the instrument gathering data,
<ReadingType>	Next M bits containing any flags put out by the instrument
<ReadingData>	Actual data stream

Data is separated by comma, space, tab, or end-of-line.

- The data analysis unit encrypts the data stream prior to transferring it to the wireless transceiver 419. The encryption is done using the 128 bit SSL encryption scheme. However, any other encryption scheme known to those skilled in the art are used
- 25 for this purpose such as DES, 3DES, or others. In addition, the Bluetooth wireless radio contains a protocol for encrypting the data, or this protocol is used to encrypt the data coming in the system prior to being transmitted.

Another method of accessing the instrument 411 specific data format in the wireless transmission unit 413 covered by this invention is the automatic download by the local server 440. During the first communication between the Patient Communication Unit 420 and wireless transmission unit 413, the Patient Communication Unit 420 reads a flag to find out the registration status of the wireless transmission unit 413 with the local server 440. If the registration flag is not set, it implies that the wireless transmission unit 413 is not registered with the local server 440 or the status of data format conversion module in the wireless transmission unit 413 is unknown. The Patient Communication Unit 420 also reads the device ID of the wireless transmission unit 413. If the registration flag is not set in the wireless transmission unit 413, Patient Communication Unit 420 transmits the wireless transmission unit 413 device ID to the local server 440, requesting the data format for the wireless transmission unit 413. Upon receiving the information from the local server 440, Patient Communication Unit 420 transmits the format to wireless transmission unit 413 to be stored in the non volatile memory, or sets the registration flag to positive. This process is also repeated every time the Wireless Transmission Unit 413 where the data format driver is to be updated by the local server 440.

In the preferred implementation of this invention, this data stream from the microprocessor is fed to the Wireless Transmission Unit 417 housed in the wireless transmission unit 413 which transmits the data to the Patient Communication Unit 420 using a short range radio link. The short range wireless radio is implemented using the existing industry standard solutions such as Bluetooth, 802.11b, 802.11a, 802.11g, home RF, zigbee, ultra-wide band, or other standard or proprietary system can also be used for this purpose. The detailed functioning of these RF links is well known to those skilled in the art or is beyond the scope of this invention. The system also supports two-way IR coupling or any other means of wireless data transfer which may be available.

The baud rate of data transfer from the instrument(s) 411 to the wireless transmission unit 413 is less than the maximum data rate supported by the wireless transceiver 417 by design. The Sensitron Personalization Protocol is designed to interface the wireless transceiver 417 capable of supporting the data rate exceeding the data rate from the instrument 411 coupled to it. In case the output data rate from the wireless transceiver 417 falls below the data rate of the incoming stream from the instrument 411, an alarm is raised which represents system malfunction, or the user is guided to take

corrective action. One instance where this situation may arise is when the data rate of the wireless transceiver 417 is reduced due to high instance of error in transmission, which forces repeated transmission of the same data set, or hence reduced overall data transmission rate. The data transmission rate is improved upon, in this instance, by removing the barriers which are causing large error in data transmission, thereby restoring the data transmission rate. Appropriate corrective actions are implemented, known to those skilled in the art, to establish the fully functional wireless link for efficient data transfer.

Built-in security features of the wireless protocols are activated in the Sensitron Personalization Protocol to secure data transmission or to prevent any unauthorized user from gaining access to the data during transmission. In addition, the data stream from the processor is encrypted using a standard protocol prior to sending the data to the transceiver unit. One method of encrypting the data is the Secure Socket Layer or SSL protocol. Other protocols may be employed for this purpose in alternate embodiments of this invention.

Patient Communication Unit 420 controls the communication between the Patient Unit 410 and the access point 430. The Patient Communication Unit 420 contains the patient identification which is downloaded during the registration of the patient in the system. Patient Communication Unit 420 contains a fully functional hand held computing device, or an equivalent device which is capable of wireless communication. The Patient Communication Unit 420 includes a wireless transceiver 427, a data processing unit 429 that takes the data packet from the wireless transceiver 427, extracts the data from the packet received from the Patient Unit 410 or the access point 430, decrypts or prepares the data packet for further transmission, or an audio or video alarm indicator 426 to communicate with the patient. In the preferred embodiment of this invention, a second wireless transceiver 425 operating with a different format is used to communicate with the next node in the system 400, shown as the access point 430. For instance, wireless transceiver 427 operates using the Bluetooth protocol or wireless transceiver 425 operates using 802.11b protocol. The alarm levels for every patient are also entered in the patient records during the registration as per the recommendation of health care workers. The Patient Communication Unit 420 establishes the wireless link with various Patient Units or exchanges data. In the preferred embodiment of this invention, Patient Communication Unit 420 uses Bluetooth wireless protocol for data exchange with Wireless Transmission

Unit 413, using serial data profile as defined under the protocol, known to those skilled in the art. Regardless of the mode of data exchange with the instruments, Patient Communication Unit 420 formats the data in the same format as shown in Table 4, with the data from various instruments appended or prioritized based upon the time stamp. The communication between the Patient Communication Unit 420 and the access point 430 uses a wireless local area network format. The destination of the data from all the Patient Communication Units in the network is the Local Server or Gateway 440.

The wireless transceiver 427 captures the data from the corresponding Patient Units or delivers the data stream to the data processing unit 429. The Patient Communication Unit 420 also contains an instrument driver library 428 with data formats for various instruments. The first N bits of incoming data stream contains the unique ID of Wireless Transmission Unit 413, which is separated by the Patient Communication Units 420 or mapped to the instrument driver library 444 in the local server 440, or the corresponding entry is extracted from the instrument driver library 428 to determine the format of the incoming data stream. This format is used for parsing the data stream or identifying various components. Next M bits contain the status of instrument(s) 411 at the end of measurement, if available. If no status is put out by the instrument(s) 411, a null string of length M is used. The status of the instrument(s) 411 is also described in the instrument driver library 428 for the given instrument(s) 411. Further processing of the data stream is conducted only if the status of the measurement is "OK".

The parsed data is evaluated using Level 0 limits, also obtained from the instrument driver library 428, or if error conditions are detected, an alarm is generated which is delivered to the Patient Unit 410 with the request to retake the measurement. In case the error is encountered a finite number of times, alternate alarm methods are used to alert the system such as an alarm in the office of the nurse. Patient Communication Unit gathers data from all the Patient Units. Depending upon the type of Patient Units involved in monitoring the patient, the data may be gathered serially or in parallel from the Patient Units. After all the data from all Patient Units is received by the Patient Communication Unit, it is presented in one screen for the review by the health care worker. They are also given the opportunity to enter any other relevant patient data query which is not measurable by an automated monitoring system such as pain score of the patient, amongst others. The health care worker is also given the option to repeat any of the measurements if it is deemed necessary. The data is sent from the Patient Communication Unit to the

Access Point after approval from the health care worker. This data is time stamped with the internal clock of the Patient Communication Unit is which synchronized with the clock of the gateway prior to sending any data to the gateway. The date or time of every measurement is associated with the arrival of the data from a Patient Unit. At the end of

5 monitoring cycle, the data from various Patient Units is formatted as shown in table 5 below.

PCU ID	Used for identifying the patient in the server by cross-referencing
<Instrument 1 ID>	First N bits containing ID of the instrument gathering data,
<ReadingType>	Next M bits containing any flags put out by the instrument
<ReadingData>	Actual data stream
.....	
<readingTimestamp>	Time or date stamp
<patientInitiatedIndicator> (OPTIONAL)	Was the reading initiated by the patient or the system
<retestIndicator> (OPTIONAL)	Was a retest necessary
<failedReadingType> (OPTIONAL)	Did the reading fail the level 0 test?
.....	
.....	
.....	
<Instrument 2 ID>	ID of the instrument gathering data
<ReadingType>	Any flags put out by the instrument
<ReadingData>	Actual data stream

Finally, the data is encoded using ANS.1 encoding scheme or formatted for the appropriate network interface. In an alternate embodiment, the data is encoded using

XML prior to formatting for the network interface. For Local Area Network interface, the data is formatted according to the Ethernet packet format, 802.3. For Wide Area Network interface, the data is formatted in the IP data format through the data processing unit 429. This serial data packet is delivered to the wireless transceiver 427 for transmission to the
5 access point 430 using WLAN, 802.11b.

In another embodiment, the local server 440 master database 447 may load the patient ID to include patient's biometric that is unique to the patient to activate the instrument(s) 411 in the Patient Unit 410 to take measurements. The same patient's biometric information can also be used to activate the Patient Communication Unit 420 to
10 establish bidirectional communication between the Patient Unit 410 with the local server 440 in the hospital or with the offsite remote server 450.

Base station or the access point 430 is the next node in the network. The access points are used to provide a communication link from the Patient Communication Unit 420 to the Local Server or Gateway 440 using the data network. The data network
15 includes wired data network in the form of Ethernet (10/100 based T or gigabit) or wireless network such as 802.11b, 802.11a, or 802.11g. The access points are commercially available, or their technical description is available in the open literature. Access point 430 contains a wireless transceiver 432 that communicates with the wireless transceiver 427 in Patient Communication Unit 420. It is noted that the wireless
20 transceiver 427 in the Patient Communication Unit 420 is designed to use different protocols to communicate with Wireless Transmission Unit 413 or the access point 430. For instance, Patient Communication Unit 420 communicates with Wireless Transmission Unit 413 using Bluetooth protocol, or it communicates with access point 430 using wireless networking protocol 802.11b. Other wireless protocols, namely 802.11a or
25 802.11g can also be used for this purpose. In an alternate embodiment, Patient Communication Unit 420 can communicate with the access point 430 using the same protocol as it uses for communication with the Wireless Transmission Unit. In this example, the communication will be limited to Bluetooth protocol for both the links. An alternate embodiment of the invention includes the access point 430 that can support
30 multiple protocols simultaneously, such as 802.11b or Bluetooth.

The data is transferred from the access point 430 to the Local Server or Gateway 440 over the local area network 470 in the facility. The data destination Local Server or Gateway 440 is a computer running a network management or maintenance program 449

to manage the flow of information from every Patient Communication Unit. The computer contains a data interface to Local Area Network or Wide Area Network 441 that separates the data from the data packets received over the network. Data gathered from the Local Area Network 470 is transferred to the computer where a software
5 program performs certain functions on the incoming data by the network management or maintenance program 449 as a part of Sensitron Personalization Protocol whereby the Local Server or Gateway 440 constantly polls the various network nodes to insure that they are in the proper functioning order. The network management or maintenance program 449 raises an alarm if any device in the system 400 does not respond. It is also
10 designed to read the battery voltage of every battery operated component in the Patient Unit 410 or the Patient Communication Unit 420. Upon the lowering of the battery voltage below a certain level, an alarm is sent to the proper personnel to charge the batteries if they are rechargeable or change them if they are not rechargeable. In addition, the Local Server or Gateway 440 also contains a client authentication module 448 with a
15 library of the mac address, a unique network address assigned to every device coupled to the network. In an embodiment of this invention, this list is dynamically updated as it is linked to the patient registration or departure from the hospital to keep only the Patient Communication Unit allocated to the patients active. Any device carried by the hospital workers is also registered by the system 400 or its address is stored in the Local Server or
20 Gateway 440. The network management or maintenance program 449 tracks all the valid mac addresses of the trusted devices allowed over the network constantly, or updates the Local Server or Gateway 440 as any change is made to the list.

When request for any service is made by any Patient Communication Unit, client authentication module 448 in the Local Server or Gateway 440 reads the mac address of
25 the data source, or compares it with the list of valid mac addresses in the Local Server or Gateway 440. Upon positive identification of the address of the requesting device, the request is processed further. Mismatch of the address of the requesting device with the list causes an alarm to be raised, or the alarm is delivered to the system administrator or the appropriate person in charge of the security. The Local Server or Gateway 440 also
30 contains temporary data analysis storage 443 for a given set of data packets ranging from one data packet to one million data packets.

The gateway is logically coupled to the local server shown as Local Server or Gateway 440. The server takes the data packet received from the gateway or tabulates the

data, using the Patient Communication Unit identifier as an index or recording monitoring device ID, in the chronological order using the date or time stamp contained in the data packet. Every time a request is made by the Patient Communication Unit to access the server, the clock on the Local Server or Gateway 440 is synchronized with the clock in Patient Communication Unit. The data packet sent by the Patient Communication Unit contains, in addition to the date or time stamp, the unique ID of the Patient Communication Unit which is preprogrammed in the Patient Communication Unit. The ID also contains another unique identifier if a single Patient Communication Unit is used to monitor multiple patients. This identifier is in the form of a location index, or simply a patient identifier. An alternate embodiment of the invention appends the ID of the person taking the reading at the patient bedside in the database. The ID of the person measuring the vital sign is entered at the point of monitoring using password or biometrics which is built in the Patient Communication Unit. The Patient Communication Unit ID is cross referenced with the master database 447, or patient specific limits are entered in the patient database from the master database 447. The master database 447 also contains patient specific rules for analyzing vital signs or other parameters which may be fetched from other databases in the hospital.

After the master data base 447 receives the end-of-transmission command from the source, the control is passed on to the data analysis or storage unit 443. The master database 447 contains the patient specific rules or limits for each parameters derived from the individual vital sign data or a combination of vital signs which are entered in the system 400 when the patient record is originated in the system 400. Multiple levels of limits are downloaded in the database 442 for every rule from master database 447. The system 400 is programmed to respond differently to violation of parameters at various levels. The preferred implementation of the system contains the three levels of threshold limits for every parameter as it deviates higher from normal or three sets of limits for deviation below the normal, as appropriate. The data is analyzed at the data analysis or storage 443, or the appropriate alarm levels are raised. The algorithm used for analysis also contains alarms created by a combination of multiple vital signs which are episode specific.

The data archival module 445 duplicates data in two locations to provide a back up for a highly reliable solution.

The system 400 supports both wired display unit 480 or wireless mobile display unit 490. The display units 480 or mobile display unit 490 also support audio or video communication using a switched or packet data network. The display manager support multiple device formats, ranging from PDA to a full screen notebook or desktop screen,
5 cellular messaging, telephone, or facsimile for reporting patient condition.

A data translation module is used to translate the data from various databases in the database 442. This invention covers both the instances where the client authentication function is contained in the gateway or the local server 440.

In an alternate embodiment the instrument driver library 418 containing the data
10 formats of Patient Unit 410 is stored in the Wireless Transmission Unit 413 in a non-volatile memory. Every Wireless Transmission Unit is programmed to identify the specific instrument 411 that it is interfaced with, as in the prior case using the cable 412 or a similar method. However, the data translation from the Patient Unit 410 is done in the Wireless Transmission Unit 413 itself rather than in the Patient Communication Unit
15 420. The instrument driver library 418 containing the data formats in the Patient Unit 410 is updated by the Local Server or Gateway 440 on a regular basis.

In an alternate embodiment, the instrument driver library 428 stored in Patient Communication Unit is the active library and the instrument driver library is not stored in Wireless Transmission Unit. The Patient Communication Unit reads the instrument ID
20 over the wireless link provided by 427, and extracts the corresponding drivers from the library 428. Patient Communication Unit downloads these drives in the Wireless Transmission Unit to enable it to exchange data with the Instrument 411. The data output from the instrument is delivered to the wireless transceiver 417 and sent to the Patient Communication Unit. The data is extracted by the data processing unit 429, using the
25 relevant information regarding the data format extracted from the library 428. Alarm levels are stored in the local memory 424 which is used for generating level 0 alarms. The following steps of formatting the data stream by combining the data from various Patient Units remains unchanged by this embodiment.

The data is formatted by the Wireless Transmission Unit 413 in the Ethernet
30 packet format or transmitted using Bluetooth or other suitable wireless radio to the Patient Communication Unit 420 in a manner described earlier.

Figure 5 shows a system 500 with another embodiment of the personalized remote patient monitoring system implementing Sensitron Personalization Protocol with separate local or remote servers coupled over Wide Area Network 560 to share or distribute the functions or risks of the System 500. The gateway function or the local server functions are handled by two different servers coupled by a Wide Area Network. The Local Server or Gateway 540 supports the user identification or network management tasks, or locally stores the data for the recently gathered readings for every PCU. Other functions such as database management, data analysis, instrument driver library update, master library maintenance, data presentation engine, or the data storage unit are handled by the remote server 550.

Figure 6 shows the relative level of alarms for one vital sign parameter, such as body temperature.

Level 0 represents the high or low levels which are used to check the validity of the data at the very source or instrument functionality problems. This level of check is made at the patient unit level itself. Violation of level 0 initiates an alarm by the server to the attending health care provider to check the functionality of the instrument or confirm that it is working correctly. An instrument diagnostic routine is executed to verify for normal functionality. If the instrument functionality is verified, then it represents extremely serious patient condition or appropriate medical treatment needs to follow immediately.

Level 1 parameters represent the emergency condition represented by a visual signal such as flashing a red signal or any preferred color the implementation. This represents the patient condition requiring emergency care. The use of flashing red is for reference only. Any other color is used to signify this condition. Violation of level 1 condition requires the attending medical personnel to provide emergency care to the patient in the appropriate fashion.

Level 2 parameters represent the serious medical condition requiring medical attention by a physician in a very short time. This condition is represented by a solid red color in the preferred implementation, although any other color is used here.

Level 3 parameters represent the deterioration of the medical condition of the patient requiring review of the patient health by informed medical personnel to review the drug compliance, review of the dietary compliance, lifestyle, etc. This level alarm

represents impending medical problems which should be addressed quickly. This condition is represented by a yellow color in the preferred implementation, although any other color is used here.

Figure 7 shows the flow of information of a personalized remote patient monitoring system implementing Sensitron Personalization Protocol describing actions taken during a monitoring process.

The Sensitron Personalization Protocol starts by the registration of the patient where a secure browser is opened on the local system with an exact image of the browser created on the server. The server is a local server in the hospital, a remote server coupled through a Wide Area Network offsite from the hospital, or both the local or remote servers operate in mirror operations to each other. In step 701 the patient is checked in, the patient's history is recorded in the system including the personal information, the diagnosis of the patient, the details of the physicians treating the patient, the drug prescription information, or any other relevant details such as the allergic reaction to any medication possible. A unique to identify the patient stored with the patient ID in the master database in the local server of the hospital. In future, the Patient Communication Unit ID is transmitted along with the patient information. In another embodiment, the patient ID may include biometric information such as finger prints, iris signature that is unique to the patient. The patient's biometric information are required to activate the instrument(s) in the Patient Unit or used to activate the Patient Communication Unit.

In step 702, after receiving the instruction regarding the vital sign monitoring schedule from the physician, the information is entered in the electronic medical record of the patient by the hospital staff, or a copy is placed in the patient record in the local server database automatically. This information is downloaded from the local server database to the appropriate Patient Communication Unit depending upon the physical location of the patient in specific part of the hospital. This schedule is also compiled for various patients in the ward or delivered to the hospital staff responsible for gathering vital signs of the patients.

In step 703, at the appropriate time, hospital staff approaches the patient bedside to initiate the measurements. The hospital staff required to help the patients with the vital sign measurement are informed using a suitable means such as a beeper message or a message on the screen of the nursing station in an alternate embodiment of the invention.

The medical personnel arrives at the patient bedside, signs in the system using the Patient Communication Unit available to them with the mobile patient units, or follows instruction delivered on the Patient Communication Unit screen to initiate monitoring. The instructions are displayed on the Patient Communication Unit to initiate the measurement routine. Prior to conducting any monitoring, the Patient Communication Unit is prompted to establish a secure wireless coupling with Patient Unit using Bluetooth radio. The Patient Communication Unit discovers all the Bluetooth radios in the vicinity by their MAC or Bluetooth addresses. The Bluetooth address of the Patient Units is stored in the memory of the Patient Communication Unit or this address is used to correlate the discovered devices with the actual Patient Units. The list of discovered devices is displayed, or the user is prompted to identify the correct Patient Unit for establishing coupling.

In step 704, the hospital staff is prompted to identify the patient who is going to be monitored. Each Patient Communication Unit has a list of the patients assigned to the list or the medical personnel are required to select the patient to be monitored by a drop down menu. After identify the patient, the medical personnel, following the instructions, proceed with measurements using instrument(s) such as a medical monitoring instrument to measure the patient's blood pressure, the body temperature, or other vital signs as prescribed by the physician. In an alternate embodiment of the invention, the medical instrument(s) in a Patient Unit are placed on the body of the patient or triggered automatically by the Patient Communication Unit as per the schedule to gather the patient's vital signs.

In step 705, the patient's measured data is processed in the data processing unit housed in the Patient Unit where it is compared against the Level 0 limits on the instruments. In case the data violates the Level 0 limits, an instrument protocol from the local memory in the Patient Unit is activated in step 706 or the instrument goes through the routine to collect the data again. The measurement routine is repeated at least one time for validity, or if the Level 0 limits are crossed in every instance, the medical personal standing by the patient bedside is informed that the instrument is malfunctioning, the measurement has not been taken correctly, the internal memory is corrupted or the patient is in serious condition. The Level 0 limits are specified by the manufacturer for each instrument. This test is aborted where Level 0 readings are not provided by the manufacturer of the instrument. Once the data collection is validated by the data

processing unit in the Patient Unit, the data is first stored in the Patient Unit local memory. In an embodiment, the writing of the data to the local memory operates in the first-in-first-out (FIFO) mode. The data packet contains the address of the instrument or the class or the type of device as per Sensitron Personalization Protocol data base. The
5 Patient Unit formats the data in the Ethernet packet data format, or any one of the similar formats for sending the data at the base band of the Wireless Transmission Unit (WTU) to the Patient Communication Unit.

In step 707, the data processing unit in the Patient Communication Unit gathers data from the various Patient Units associated with it sequentially or in parallel
10 connection. The data is assembled in one screen or presented to the care provider for review. In case of automated monitoring of patient, it is possible to eliminate the screening step. After a successful review of the data, it is formatted as per Sensitron Personalization Protocol for transmission over the network. The information is encrypted using Secure Socket Layer standard, or it is submitted to the wireless transceiver for
15 transmission to the access point using 802.11b wireless Local Area Network protocol encoding the data in ANSI.1 or XML.

In step 708 to 710, the Sensitron Personalization Protocol formatting instructions are used by the local server to extract data from the incoming data stream. In order to secure against the unauthorized access to the data during transmission from the Patient
20 Communication Unit to the access point, additional verification of the Patient Communication Unit mac addresses is made at the gateway. Prior to transmitting the data through the output buffer, a null data stream is sent out by the transceiver. The access point receives the data stream or decodes the address of the instrument(s) in the Patient Unit. The access point is programmed to contain the list of all the Patient Communication
25 Units registered with the system. Every time a Patient Communication Unit is added to a system installation, the information is sent to the local server that updates the Patient Communication Unit address register at the access points. Upon receiving the data packet, the access point strips of the Patient Communication Unit address or match it with the stored data base. If a match is found, the access point sends an acknowledgement to the
30 Patient Communication Unit using a predetermined random data stream of length varying from two bits to 128 bits. If the address match is not found, then the Patient Communication Unit sends a back data stream in the acknowledgement cycle. This allows the access point or the Patient Communication Unit to confirm their identities

before sending the data to insure the data confidentiality. In an alternate embodiment, the address of the Patient Communication Unit is stored in the Local Server or Gateway or the verification is done in the Local Server or Gateway before any data transmission commences from the Patient Communication Unit to the access point. The data is
5 delivered to the Local Server or Gateway by the access point by using a wired or a wireless Local Area Network. The data is encrypted all during the transmission to the Local Server or Gateway. The Sensitron Personalization Protocol supports a multiplicity of data encryption protocols as known to those skilled in the state of the art. The Local Server or Gateway strips of the header or decrypts the data.

10 In step 711, the server extracts the patient data packet or compare with the patient data from the master data base that contains the following;

1. Web address of the local server.
2. MAC address of the access point or gateway used to receive the data
3. MAC address or ID of the PCU
- 15 4. Class, type of the Patient Unit
5. The time of measurement
6. The ID of the health care personnel assisting the patient, patient ID index
7. The patient vital sign data

The patient is identified by the Patient Communication Unit ID. In an alternate
20 embodiment, the patient identity is matched with the Patient Communication Unit ID or stored in the local server during the registration. The Patient Communication Unit ID derived from the incoming data stream is used to match or retrieve the patient data.

In step 712 to 715, the local server formats the patient data or retrieves vital signs of the patient. Based on the rules the patient vital sign data is analyzed or the alarms are
25 generated according to the levels prescribed for the patient. If any alarms are generated, the local server prepares or sends the report to the health care provider monitoring the patient. The health care provider approaches the patient or carries out the adequate treatment or instructions to treat the patient.

In step 716, the local server goes in a sleep state at the end of the monitoring cycle, to be woken up by the Sensitron Personalization Protocol *system from the wait* state at a predetermined time or repeats the instructions starting in step 703.

WHAT IS CLAIMED

1. A Personalized Remote Patient Monitoring System comprising:
a network system in the health care environment enabled by a Sensitron
5 Personalization Protocol (SPP) to communicate data in the network, wherein the network
comprising a plurality of communication devices coupled to each other, wherein the
devices further comprising a Patient Unit; a Patient Communication Unit; an access point
and a Gateway or a local server coupled to each other through a Local Area Network.
2. The system of claim 1 wherein the network includes standard wireless or
10 wired network protocols.
3. The system of claim 1 wherein the Patient Unit couples measured data to
the Patient Communication Unit.
4. The system of claim 1 wherein the Patient Communication Unit couples to
an access point.
- 15 5. The system of claim 1 further comprising a remote server implementing
the Sensitron Personalization Protocol, wherein the remote server couples to the local
server through a Wide Area Network with a firewall.
6. The network of claim 5, wherein the network is served by a
communication links including dial up access, cable modem access, DSL, WLAN
20 802.11b/ g/ a, fiber optics, LMDS, MMDS, cellular or VSAT.
7. The system of claim 1 further comprising a wired or a wireless mobile
display unit coupled to the network to monitor patient data.
8. The system of claim 7, wherein the wireless mobile display unit includes a
cell phone, a PDA, a medical device assistant, a pager, a lap top computer or personal
25 computer coupling to the Wide Area Network.
9. The system of claim 1 wherein the access point is a base station.
10. The system of claim 7, wherein the wired display unit includes a cell
phone, a PDA, a lap top computer or personal computer coupled to the Local Area
Network.
- 30 11. The system of claim 1, wherein the local server includes

a computer system with I/O devices or a storage subsystem; wherein the computer further comprising a the functions of :

a data interface to the Local Area Network or Wide Area Network;

a data base for vital data storage;

5 a data analysis module with storage for data processing;

an instrument driver library;

a data archiving storage back up;

a data presentation module;

a master database;

10 a client authentication module; and

a network management or maintenance program.

12. The system of claim 1, wherein the server couples to a storage system through a Local Area Network.

13. The system of claim 1, wherein the server couples to a display unit through
15 a Local Area Network.

14. The system of claim 11, wherein the server couples to a mobile display unit through a Local Area Network or an access point.

15. The system of claim 5, wherein the remote server duplicates the vital function or data storage of the local server.

20 16. The system of claim 1 wherein the Patient Unit comprises of a Wireless Transmission Unit coupled to an instrument through a cable or a multi I/O pin connector.

17. The system of claim 16 wherein the coupling between the Wireless Transmission Unit and the instruments is external or internal to the instrument enclosure.

18. The system of claim 16 wherein one or more I/O pins in the connector are
25 coupled to the power line or to the ground to represent the instrument ID linked to the Wireless Transmission Unit.

19. The system of claim 18 wherein the instrument ID is stored in the master data base of the local server.

20. The system of claim 16 wherein the Wireless Transmission Unit includes an I/O interface which is programmable, a wireless transceiver, a data processing unit or an audio or visual alarm indicator.
21. The system of claim 20 wherein the data processing unit includes a non
5 volatile memory with the instrument ID programmed into the non volatile memory or accessible by the Wireless Transmission Unit.
22. The system of claim 20 wherein the audio or visual alarm indicator includes sound, voice commands, graphics, lights on or off state, light flashes, text messages or symbols.
- 10 23. The system of claim 20 wherein the I/O interface includes RS 232, RS 485, universal serial bus (USB 1.0 or USB 2.0) standard, IEEE488 bus, medical information bus, or parallel data output or any similar data formatting standard.
24. The system of claim 20 wherein the transceiver carries out bidirectional
15 data exchange between the Patient Communication Unit or the instrument by receiving data from the instrument or sending commands to the instrument.
25. The system of claim 20 wherein the transceiver formats the data received from the instrument into Sensitron Personalization Protocol standard or transmits the data to the Patient Communication Unit through a wireless network protocol.
26. The system of claim 20 further comprises of a local memory wherein the
20 local memory stores measured data by a first in first out algorithm to preserve a latest data.
27. The system of claim 26 wherein the local memory is backed by battery power for a defined period of time to preserve vital data for later recovery in case of power interrupts or other communication device failure.
- 25 28. The system of claim 20 wherein the data processing unit includes a program to encrypt, or format the data from the instrument before transmission by the wireless transceiver, or to decode the data received from the wireless transceiver to the instrument.
29. The system of claim 20 wherein the data processing unit includes
30 functions to compare patient data with instrument preset proper operation limits to initiate proper level alarm.

30. The system of claim 20 further comprises of an instrument driver library with non volatile memory wherein the instrument preset proper operation limits or the data format of the instrument is stored or updated by the local server.
31. The system of claim 16 wherein the instrument is a medical monitoring
5 instrument, an actuator or an environmental monitor.
32. The system of claim 16 further comprises of a plurality of instruments made up of medical monitoring instruments, or actuators, or environmental monitors or a combination of all.
33. The system of claim 1 wherein the Patient Unit is mobile or portable.
- 10 34. The system of claim 1 wherein the Patient Communication Unit includes a wireless transceiver; a data processing unit; or an audio or visual alarm indicator.
35. The system of claim 34 further comprises of a local memory wherein the local memory stores measured data by first in first out algorithm to preserve the latest data.
- 15 36. The system of claim 35 wherein the local memory is backed by battery power for a defined period of time to preserve vital data for later recovery in case of power interrupts or other communication device failure.
37. The system of claim 34 further comprises of an instrument driver library with non volatile memory wherein the instrument preset proper operation limits or the
20 data format of the instrument is stored or updated by the local server.
38. The system of claim 34, wherein the data processing unit extracts the data packet from the wireless transceiver, decrypts or prepares the data packet for further transmission.
39. The system of claim 34, wherein the wireless transceiver operates using
25 standard wireless Local Area Network protocol.
40. The system of claim 34, wherein the audio or visual alarm indicator includes sound, voice commands, lights on and/or off state, light flashes, text messages, graphics or symbols.

41. The system of claim 1, wherein the Patient Communication Unit simultaneously communicates to a plurality of Patient Units sequentially or in parallel connection while communicating to an access point.
42. The system of claim 1, wherein the Patient Communication Unit includes a
5 PDA or a lap top computer coupling to the Local Area Network through an access point.
43. The system of claim 1, wherein the Patient Communication Unit is portable or mobile.
44. The system of claim 1, further comprising a medical device assistant wherein the device assistant communicates with an access point to receive data or
10 instruction from the local server.
45. The system of claim 11, wherein the master data base comprising:
- a Web address of the local server;
 - a MAC address of the access point used to receive the data;
 - a MAC address or ID of the Patient Communication Unit;
 - 15 an instrument ID or an ID to specify the Class or type of the instrument;
 - a time stamp of data measurement;
 - an ID of the health care worker assisting the patient, patient ID or patient ID index; and
 - a patient vital sign data.
46. The system of claim 11, wherein the client authentication module
20 dynamically updates or checks with the master data base to match the mac address or the network address assigned to every device coupled to the network; wherein the patient or health care worker ID are linked to the Patient Communication Unit assigned to the patients.
47. The system of claim 45, further comprising biometric data for patient or
25 health care worker ID.
48. The system of claim 47, wherein the biometric data of the patient or health care worker are authenticated by the local server data base to activate the Wireless Transmission Unit or the Patient Communication Unit.

49. The system of claim 5, wherein the local server or the remote server shares or distribute a functions or risks of the system.

50. The system of claim 1, wherein the system is modular or scalable to communicate with increasing number of monitor devices with plug-and-play features or
5 increasing number of patients without.

51. A Sensitron Personalization Protocol comprising the functions of:
authenticating the identification and monitoring of data measured entered
or generated by a patient to establish security;
analyzing measured data and establishing a level alarm warning based on
10 predetermined rules;
encrypting and encoding the data in ANSI.1 or XML
administering of treatment and instructions to patient

52. The protocol of claim 51, further comprises biometric data for patient or health care worker ID.

53. The protocol of claim 51, wherein the local server authenticates the
15 identifications of patients, instruments, health care workers, communication devices or data validity.

54. A Personalized Remote Patient Monitoring method comprising the steps
of:
20 enabling a network system using a Sensitron Personalization Protocol to
exchange data to a local server through transmission methods including wireless,
wired or a combination of both;
enabling communication devices using a Sensitron Personalization
Protocol to take patient vital signs data or exchange data to the network system;
25 encrypting or formatting data to Sensitron Personalization Protocol
standard for security or privacy in the network system;
using a Local Area Network, or a combination of Local Area Network or a
Wide Area Network to facilitate the exchange of data in the network;

authenticating the ID of patients, instruments, health care workers, communication devices or data validity;

analyzing the patient data for validity or check data with predetermined rules to set level alarm alerts or to provide health care instructions; or

5 providing patient monitoring, instructions to care or to administer treatment to a patient in real time.

55. The method of claim 54, further comprises using biometric data for patient or health care worker ID.

56. The method of claim 54, wherein the instruments include medical
10 monitoring instruments, actuators, or environmental monitors.

57. The method of claim 54, wherein the communication devices include Patient Unit, Patient Communication Unit, access point, gateway, server, monitors or displays.

58. A local server running on Sensitron Personalization Protocol comprising:
15 a computer system with I/O devices or a storage subsystem; wherein the computer further comprising a the functions of :

a data interface to the Local Area Network or Wide Area Network;

a data base for vital data storage;

a data analysis module with storage for data processing;

20 an instrument driver library;

a data archiving storage back up;

a data presentation module;

a master database;

a client authentication module; and

25 a network management or maintenance program.

59. The server of claim 58, further comprises a storage system or a display unit or a mobile display unit coupled through a Local Area Network.

60. The server of claim 58, further comprises a remote server coupled through a Wide Area Network, wherein the remote server duplicates the vital function or data storage of the local server.

61. A Patient Unit enabled to run on Sensitron Personalization Protocol
5 comprising:

a Wireless Transmission Unit coupled to an instrument through a cable or a multi I/O pin connector, communicating to a vicinity radio or transceiver running on Sensitron Personalization Protocol.

62. The Unit of claim 61 wherein the coupling between the Wireless
10 Transmission Unit or the instruments comprises external or internal to the instrument enclosure.

63. The Unit of claim 61 wherein the wherein one or more I/O pins in the connector are coupled to the power line or to the ground to represent the instrument ID linked to the Wireless Transmission Unit.

64. The Unit of claim 61 wherein the Wireless Transmission Unit includes an
15 I/O interface, a wireless transceiver, a data processing unit or an audio or visual alarm indicator.

65. The Unit of claim 64 wherein the data processing unit comprises of a non volatile memory with the instrument ID programmed into the non volatile memory.

66. The Unit of claim 64 wherein the audio or visual alarm indicator includes
20 sound, voice commands, lights on or off state, light flashes, text messages or symbols.

67. The Unit of claim 64 wherein the I/O interface includes RS 232, RS 485, universal serial bus (USB 1.0 or USB 2.0) standard, IEEE 488, Medical Information Bus or parallel data output or any similar data formatting standard.

68. The Unit of claim 64 wherein the transceiver carries out bidirectional data
25 exchange between the Patient Communication Unit or the instrument by receiving data from the instrument or sending commands to the instrument.

69. The Unit of claim 64 wherein the transceiver formats the data received
30 from the instrument into Sensitron Personalization Protocol standard or transmits the data to the Patient Communication Unit through a wireless network protocol.

70. The Unit of claim 64 further comprises of a local memory wherein the local memory stores measured data by a first in first out algorithm to preserve the latest data.

71. The Unit of claim 70 wherein the local memory is backed by battery
5 power for a defined period of time to preserve vital data for later recovery in case of power interrupts or other communication device failure.

72. The Unit of claim 64 wherein the data processing unit further comprises of a program to encrypt, or format the data from the instrument before transmission by the wireless transceiver, or to decode the data received from the wireless transceiver to the
10 instrument.

73. The Unit of claim 64 wherein the data processing unit includes functions to compare patient data with instrument preset at proper operation limits to initiate proper level alarm.

74. The Unit of claim 64 further comprises of an instrument driver library with
15 non volatile memory wherein the instrument preset proper operation limits or the data format of the instrument is stored or updated by the local server.

75. The Unit of claim 61 wherein the instrument is a medical monitoring instrument, an actuator or an environmental monitor.

76. The Unit of claim 61 further comprises of a plurality of instruments made
20 up of medical monitoring instrument, actuator, environmental monitor or a combination of all.

77. The Unit of claim 61 wherein the Patient Unit is mobile or portable.

78. The Unit of claim 61 wherein the vicinity radio or transceiver is a Patient Communication Unit.

25 79. A Patient Communication Unit enabled to run on Sensitron Personalization Protocol comprising:

a wireless transceiver communicating to an access point or to a vicinity transceiver running on Sensitron Personalization Protocol;

a data processing unit coupled to the wireless transceiver wherein data are
30 formatted and encrypted; and

an audio or visual alarm indicator wherein the level of alarm and patient treatment instructions are displayed after analyzing or validating the data.

80. The Unit of claim 79 further comprises of a local memory wherein the local memory stores measured data by first in first out algorithm to preserve the latest
5 data.

81. The Unit of claim 79 wherein the local memory is backed by battery power for a defined period of time to preserve vital data for later recovery in case of power interrupts or other communication device failure.

82. The Unit of claim 79 further comprises of an instrument driver library with
10 non volatile memory wherein the instrument preset proper operation limits or the data format of the instrument is stored or updated by the local server.

83. The Unit of claim 79, wherein the data processing unit extracts the data packet from the wireless transceiver, decrypts or prepares the data packet for further transmission.

84. The Unit of claim 79, wherein the wireless transceiver operates using the
15 Bluetooth protocol or wireless 802.11b protocol.

85. The Unit of claim 79, wherein the audio or visual alarm indicator includes sound, voice commands, lights on or off state, light flashes, text messages or symbols.

86. The Unit of claim 79, wherein data is exchanged simultaneously to a
20 plurality of Patient Units while communicating to an access point.

87. The Unit of claim 79, wherein the Unit includes a PDA or a lap top computer coupled to the Local Area Network through an access point.

88. The Unit of claim 79, wherein the Patient Communication Unit is portable or mobile.

89. The Unit of claim 79, further comprising a medical device assistant
25 wherein the device assistant communicates with an access point to receive data or instruction from the local server.

90. A data format of the input to a wireless transceiver comprising:
a first N bits containing ID of an instrument gathering data;
30 a next M bits containing flags put out by the instrument; and

an actual data stream, wherein the data is separated by comma, space, tab, or end-of-line.

91. The format of claim 90, wherein the data is in either serial or parallel format.

5 92. The format of claim 90, wherein the format forms the protocol used to encrypt the data coming in the Sensitron Personalization Protocol system prior to being transmitted.

93. A format of a data stream assembled in a Patient Communication Unit for data transfer to a local server comprising:

10 a Patient Communication Unit ID;

a N bits of instrument ID;

a Next M bits containing any flags put out by the instrument;

an actual data stream;

a time or date stamp;

15 an optional patient initiator indicator;

an optional retest indicator;

an optional failed reading indicator;

an instrument ID gathering data;

any flags put out by the instrument; or

20 an actual data stream.

94. The format of claim 93, wherein the data is in either serial or parallel format.

95. The format of claim 93, wherein the format forms the protocol used to encrypt the data coming in the Sensitron Personalization Protocol system prior to being
25 transmitted.

96. The system of claim 20 wherein the I/O interface of the Wireless Transmission Unit is reprogrammed to exchange data with multiple instruments.

97. The system of claim 16 wherein the instrument includes a

combination of instruments that are used for monitoring a patient or this combination is varied for each use in real time.

98. The system of claim 16 wherein the combination includes a plurality of medical monitoring instrument(s), actuator(s), environmental monitors or a combination
5 of all the above.

99. The system of claim 16 wherein patient data query is entered to the master data base along with the data from the Patient Unit(s).

100. The system of claim 36 wherein the data includes patient data from the Patient Unit(s) or the patient data query approved by a health care worker before
10 submitting to the master data base.

101. The system of claim 100, wherein the health care worker is given the option to repeat the measured data from the Patient Unit(s).

102. The system of claim 1 wherein the gateway polls all the Patient Units or Patient Communication Units at regular interval to check their status including battery
15 voltage, wherein any degradation or non performing Patient Unit or Patient Communication Units are reported to maintenance organization.

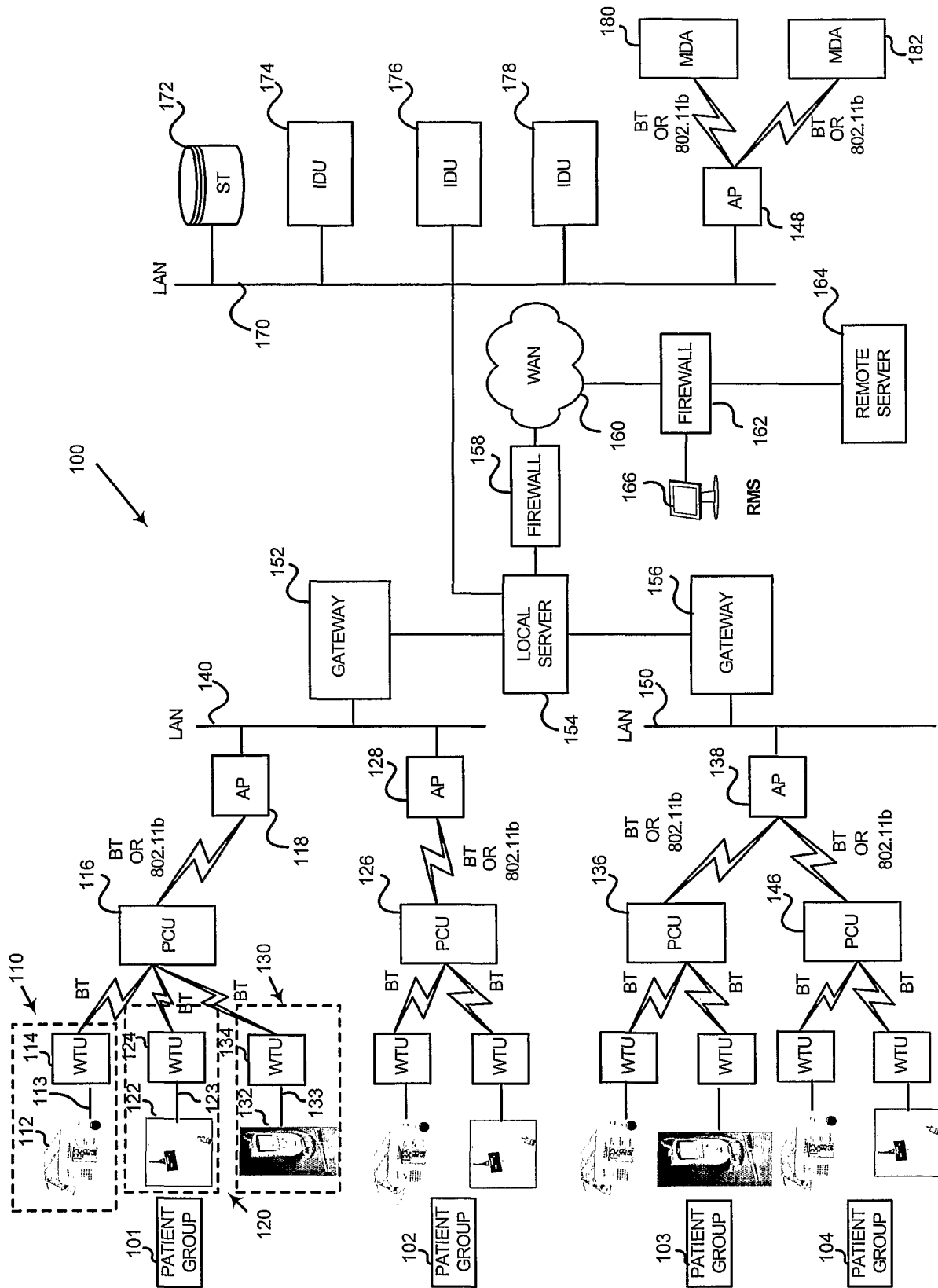
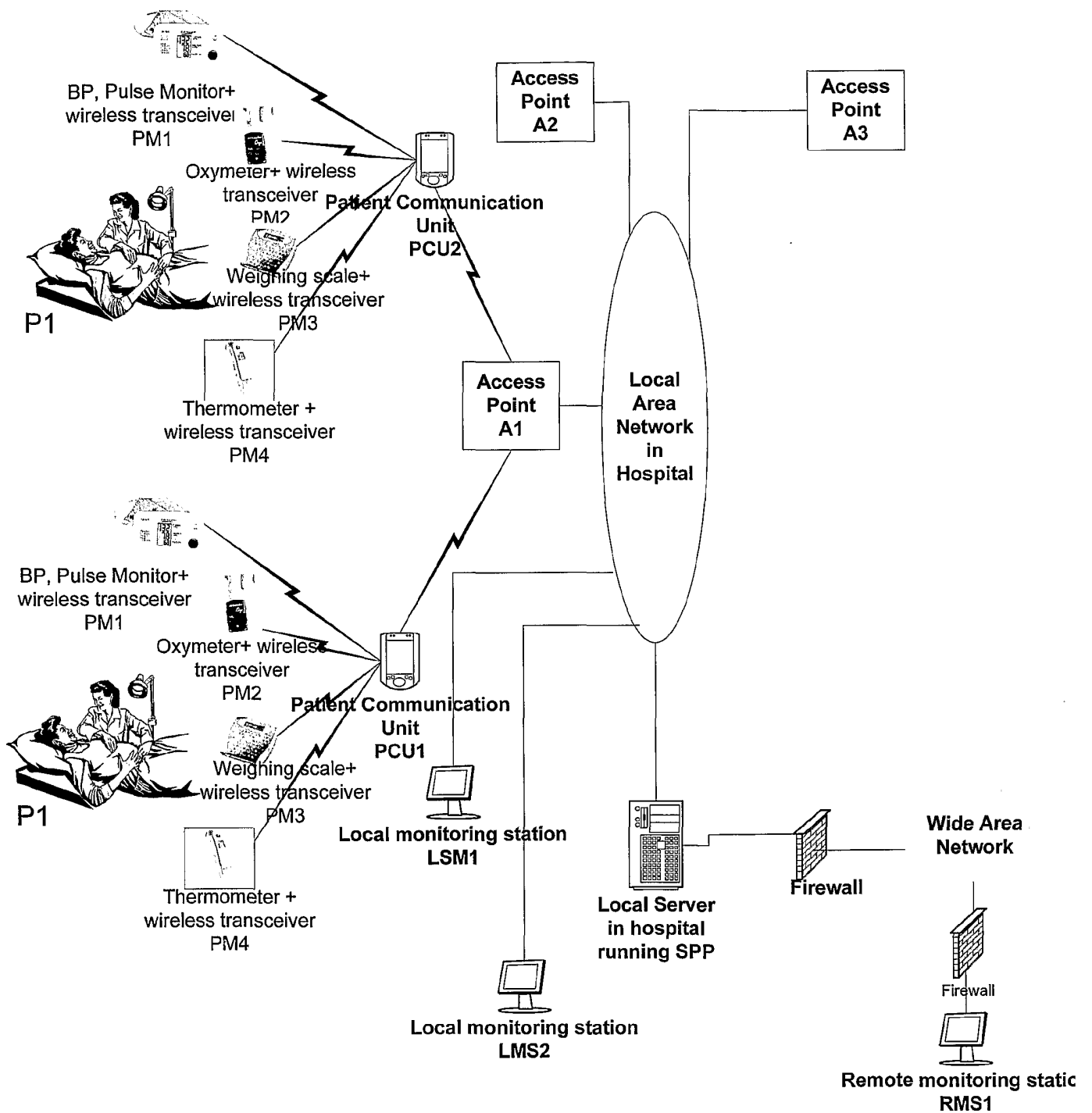


FIGURE 1



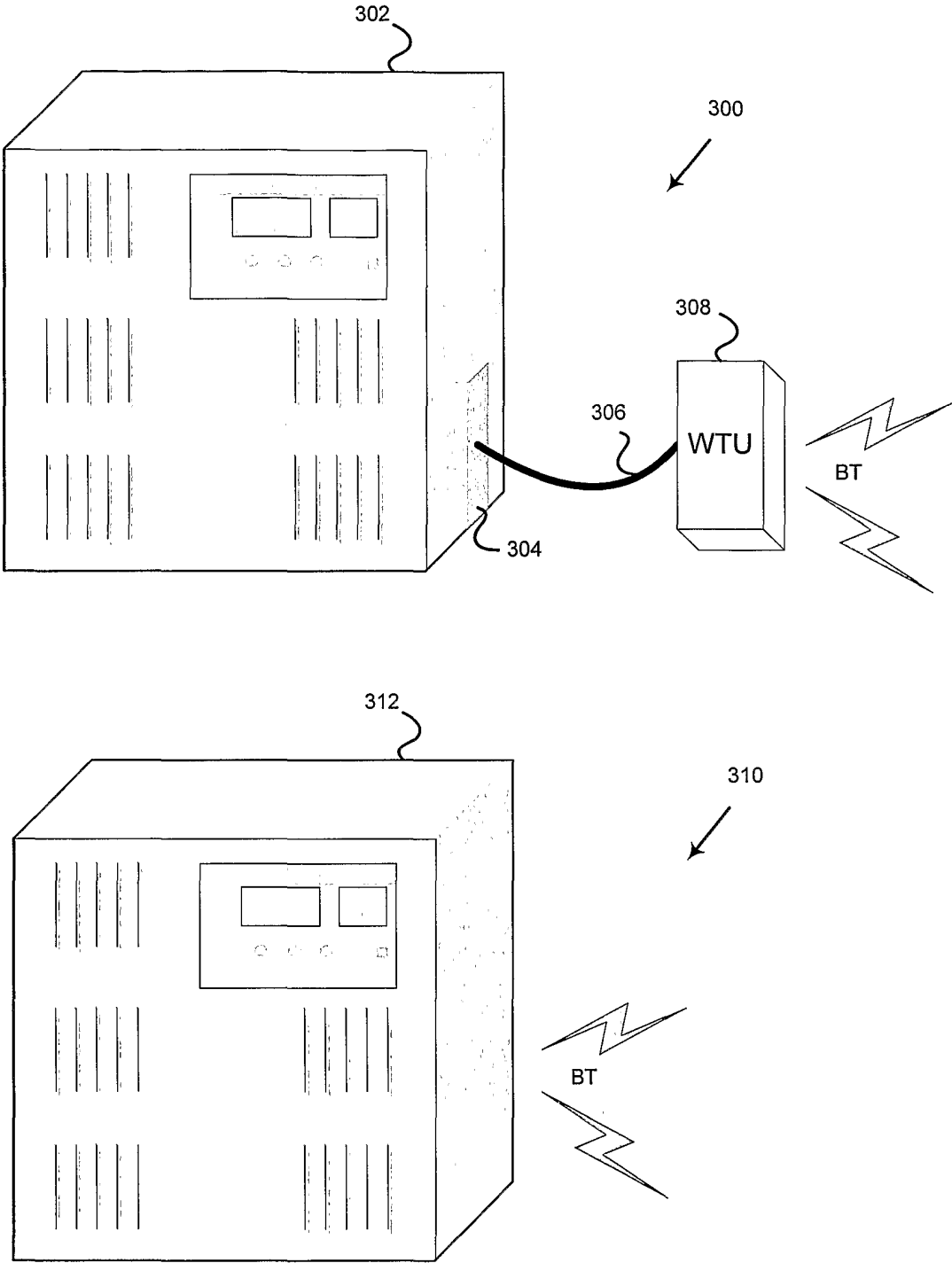


FIGURE 3

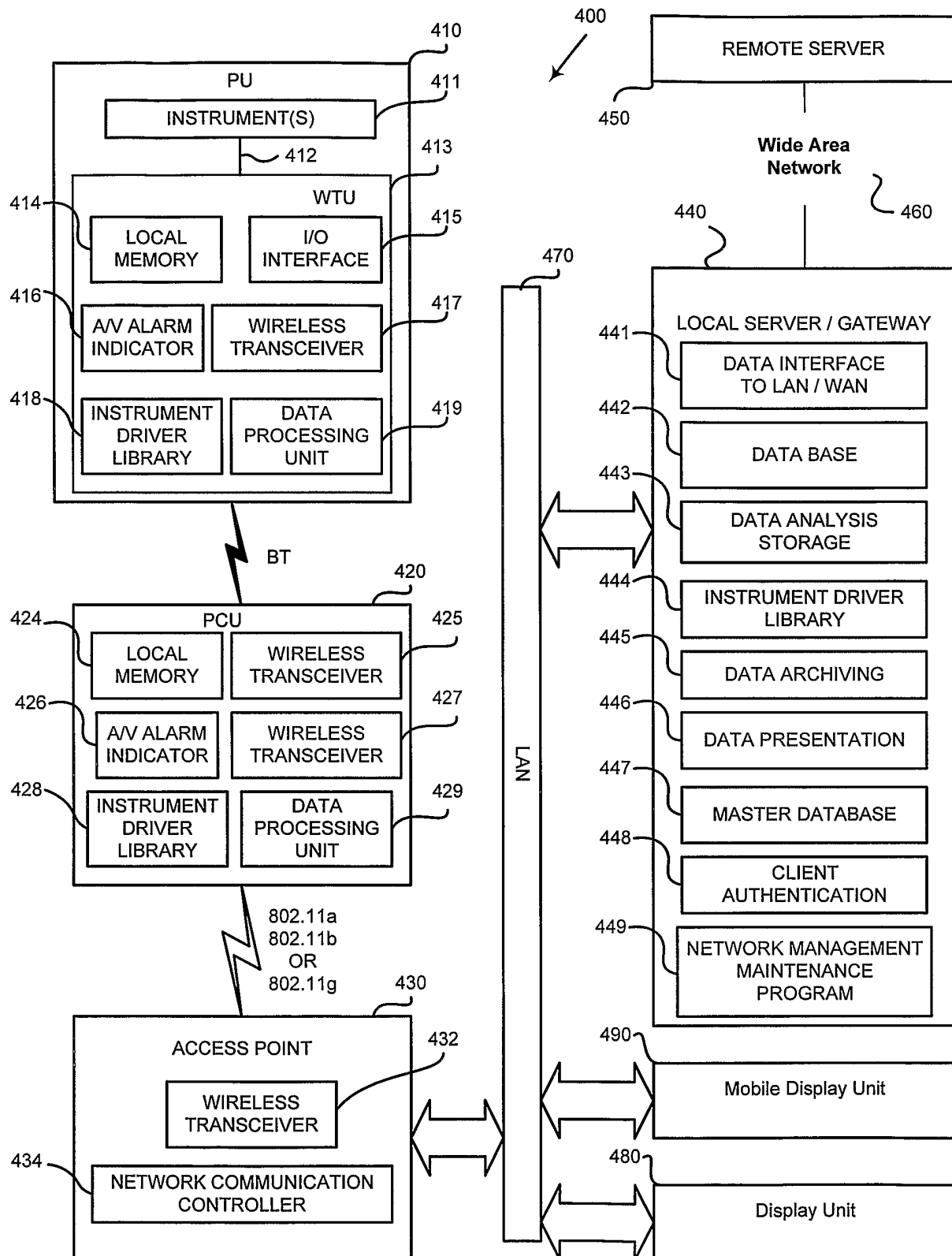


FIGURE 4

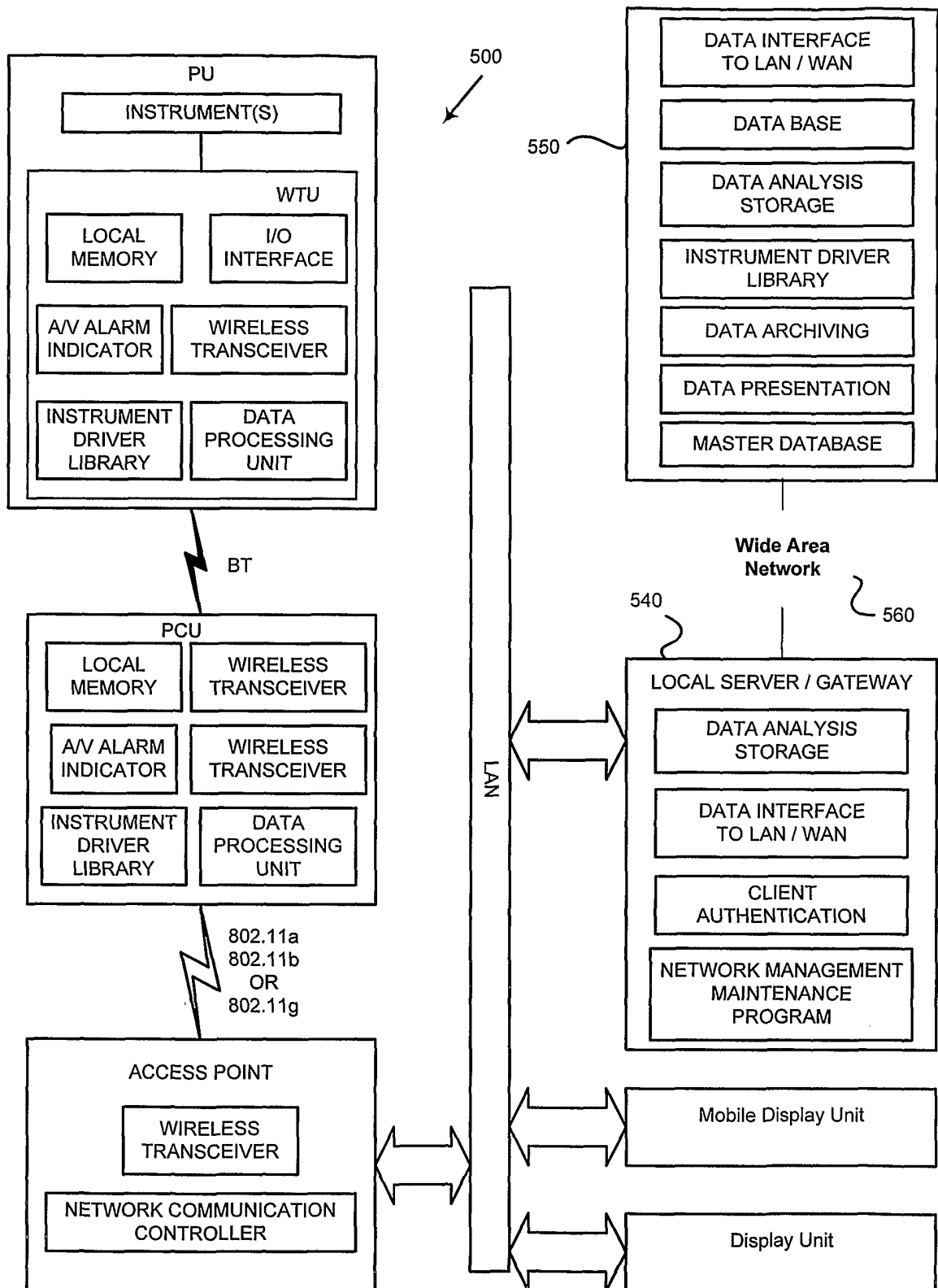


FIGURE 5

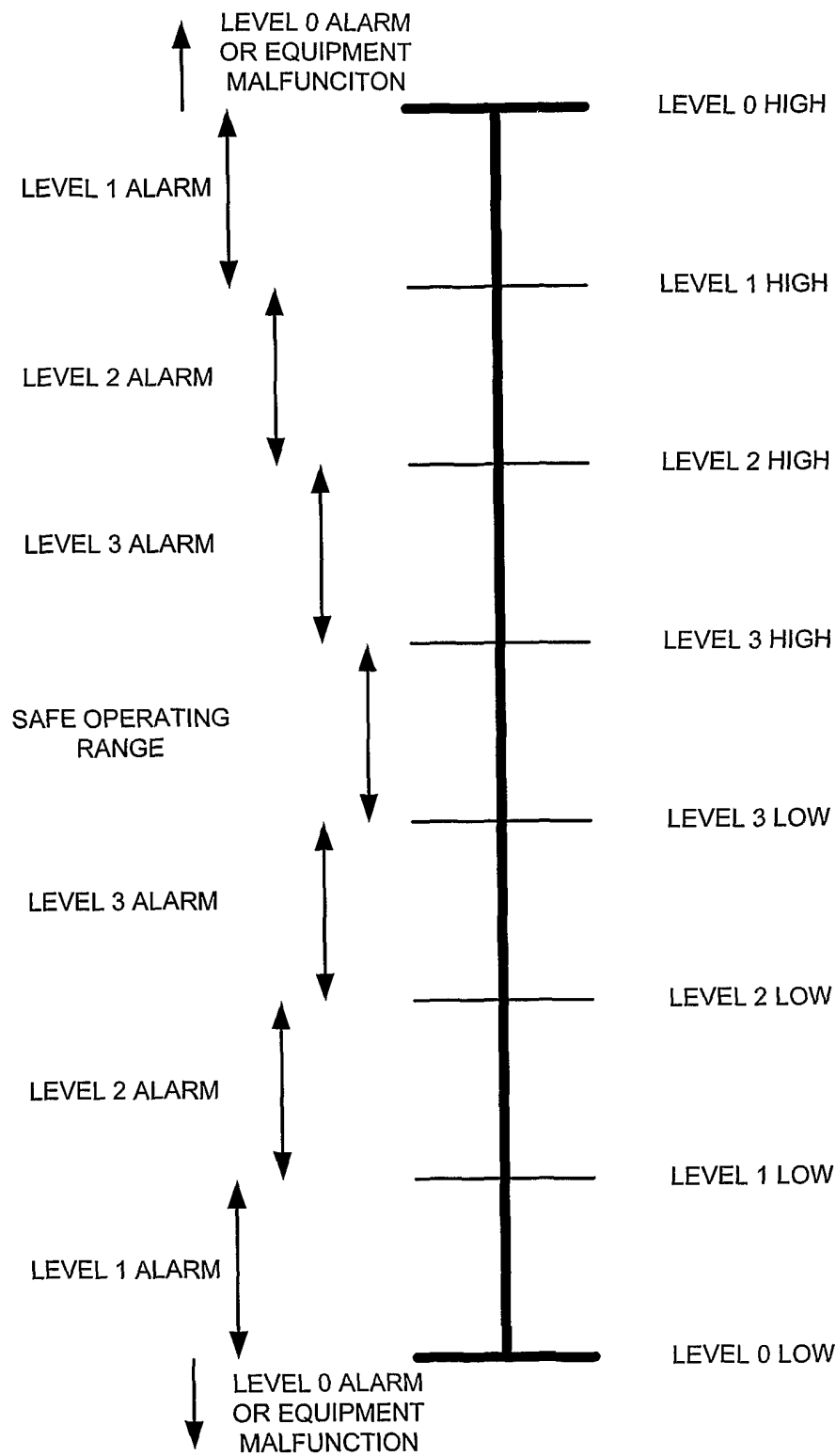


FIGURE 6

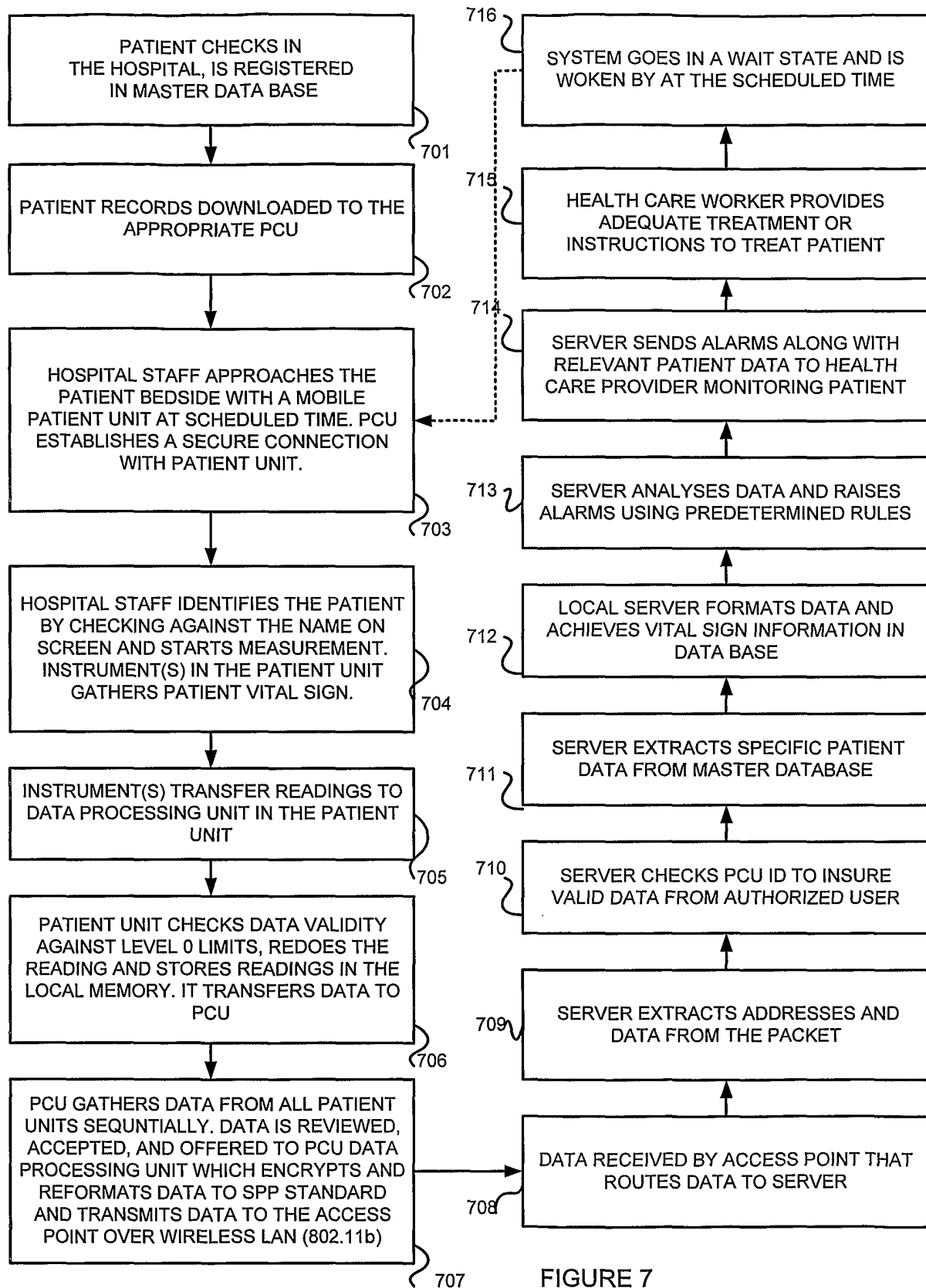


FIGURE 7