US007103511B2

(12) **United States Patent**
Petite

(10) **Patent No.: US 7,103,511 B2**
(45) **Date of Patent: Sep. 5, 2006**

(54) **WIRELESS COMMUNICATION NETWORKS FOR PROVIDING REMOTE MONITORING OF DEVICES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 716 days.

(21) Appl. No.: **09/925,269**

(22) Filed: **Aug. 9, 2001**

(65) **Prior Publication Data**

US 2002/0019725 A1 Feb. 14, 2002

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/812,809, filed on Mar. 20, 2001, now abandoned, which is a continuation-in-part of application No. 09/412,895, filed on Oct. 5, 1999, now Pat. No. 6,218,953, which is a continuation-in-part of application No. 09/172, 554, filed on Oct. 14, 1998, now Pat. No. 6,028,522, and a continuation-in-part of application No. 09/271, 517, filed on Mar. 18, 1999, now abandoned, and a continuation-in-part of application No. 09/439,059, filed on Nov. 12, 1999, now Pat. No. 6,437,692.

(51) **Int. Cl.**
G06F 15/00 (2006.01)

(52) **U.S. Cl.** **702/188**; 340/870.06; 455/423

(58) **Field of Classification Search** 702/188, 702/57; 315/133–134, 139, 149; 340/870.01, 340/870.06, 870.07, 870.16; 455/73, 403, 455/422–423

See application file for complete search history.

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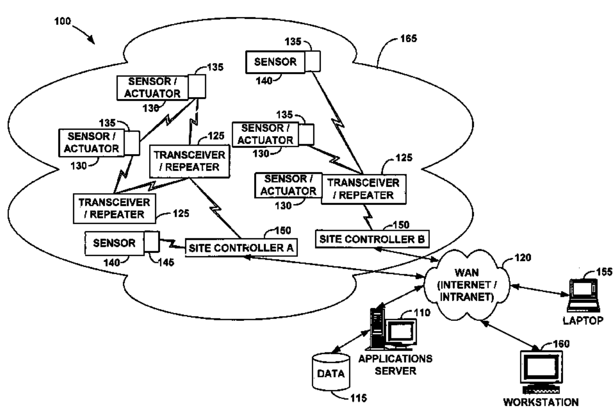
(57) **ABSTRACT**

Wireless communication networks for monitoring and controlling a plurality of remote devices are provided. Briefly, one embodiment of a wireless communication network may comprise a plurality of wireless transceivers having unique identifiers. Each of the plurality of wireless transceivers may be configured to receive a sensor data signal from one of the plurality of remote devices and transmit an original data message using a predefined wireless communication protocol. The original data message may comprise the corresponding unique identifier and sensor data signal. Each of the plurality of wireless transceivers may be configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data message using the predefined communication protocol. The repeated data message may include the sensor data signal and the corresponding unique identifier. Furthermore, at least one of the plurality of wireless transceivers may be further configured to provide the original data messages and the repeated data messages to a site controller connected to a wide area network. The site controller may be configured to manage communications between the wireless communication network and a host computer connected to the wide area network.

29 Claims, 10 Drawing Sheets



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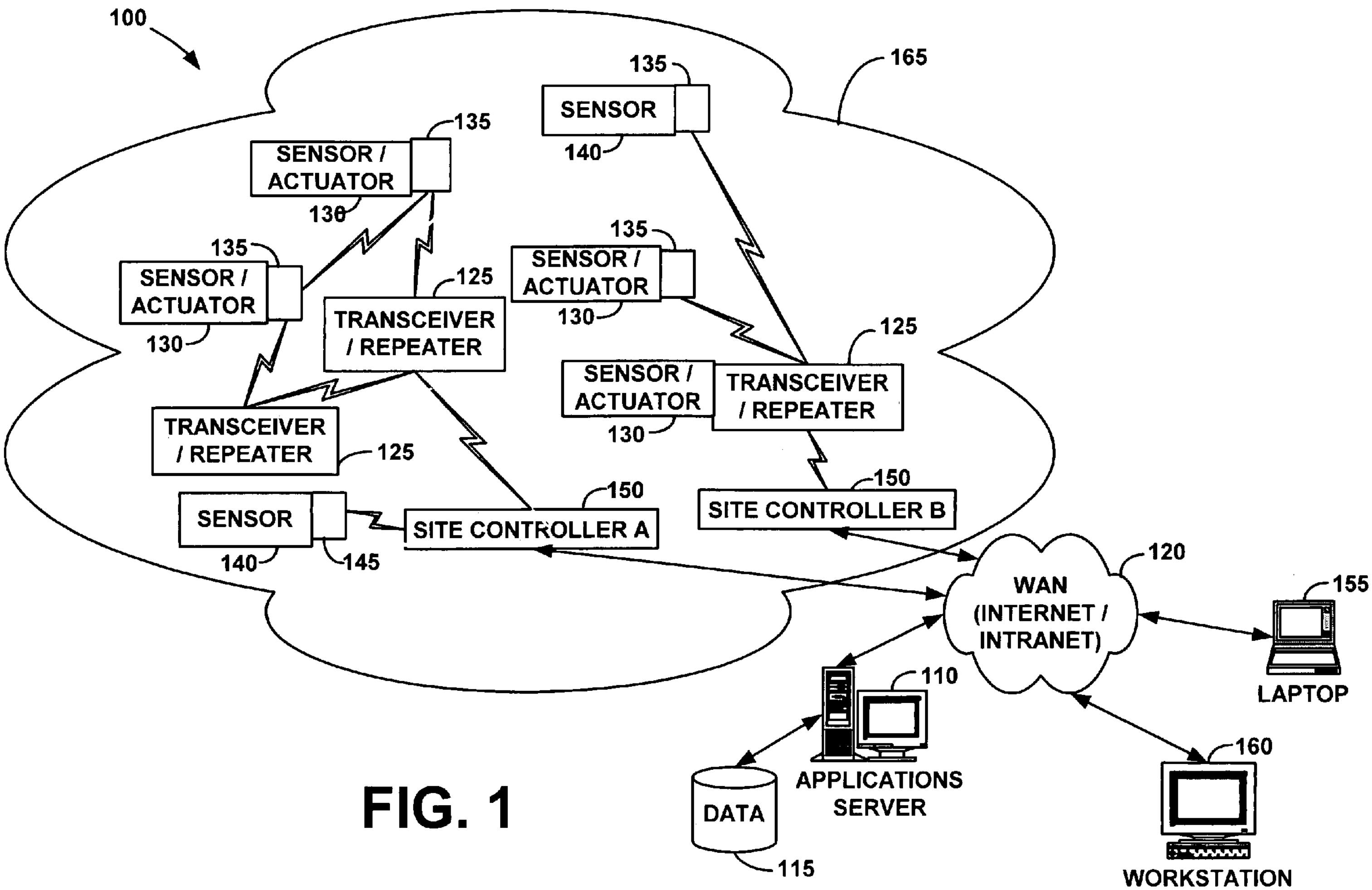

100
165
SENSOR
135
140
SENSOR / ACTUATOR
135
130
SENSOR / ACTUATOR
135
130
TRANSCEIVER / REPEATER
125
SENSOR / ACTUATOR
135
130
TRANSCEIVER / REPEATER
125
SENSOR / ACTUATOR
130
TRANSCEIVER / REPEATER
125
SENSOR
140
145
SITE CONTROLLER A
150
SITE CONTROLLER B
150
WAN (INTERNET / INTRANET)
120
LAPTOP
155
APPLICATIONS SERVER
110
DATA
115
WORKSTATION
160

FIG. 1

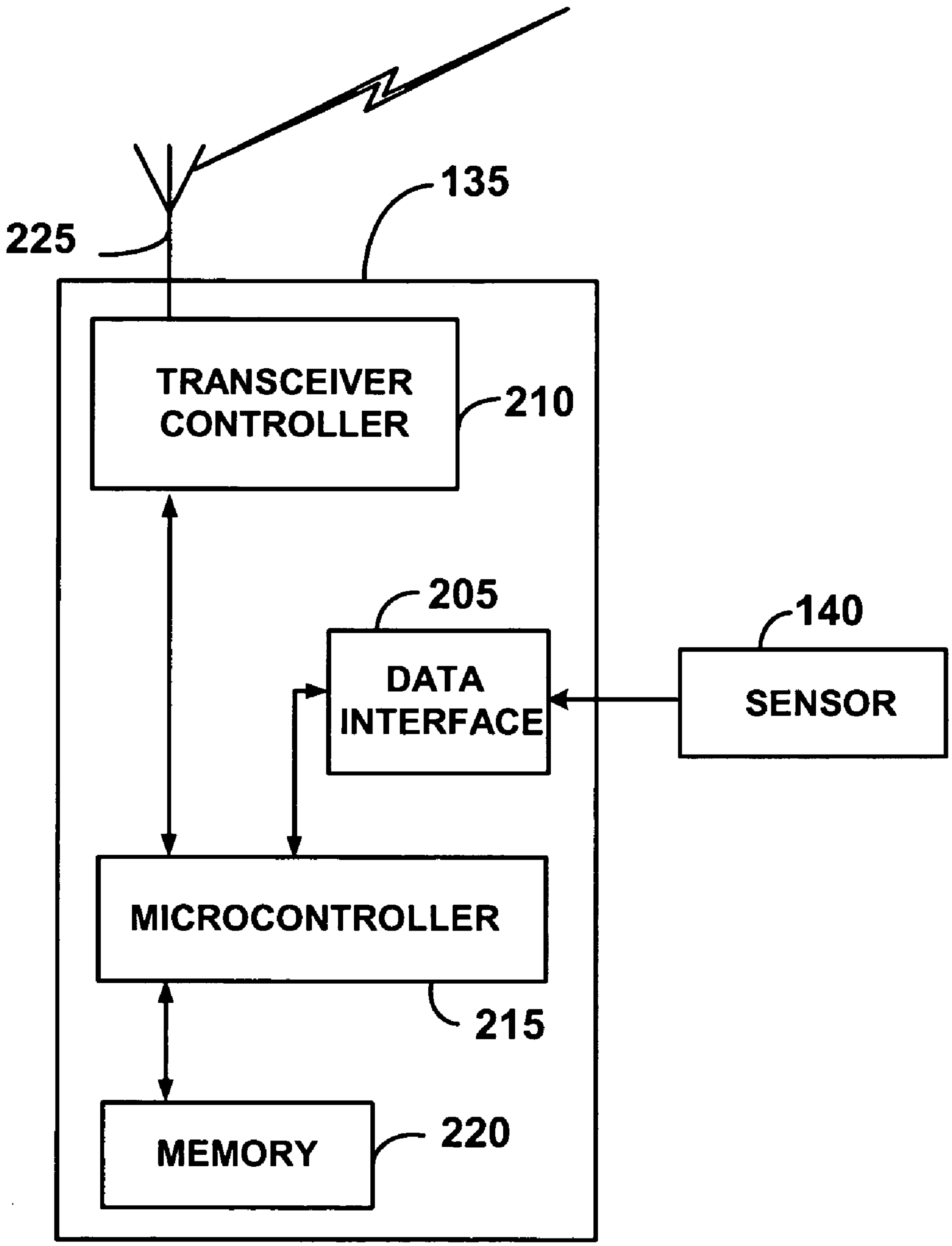

135
225
TRANSCEIVER CONTROLLER
210
205
DATA INTERFACE
140
SENSOR
MICROCONTROLLER
215
MEMORY
220

FIG. 2

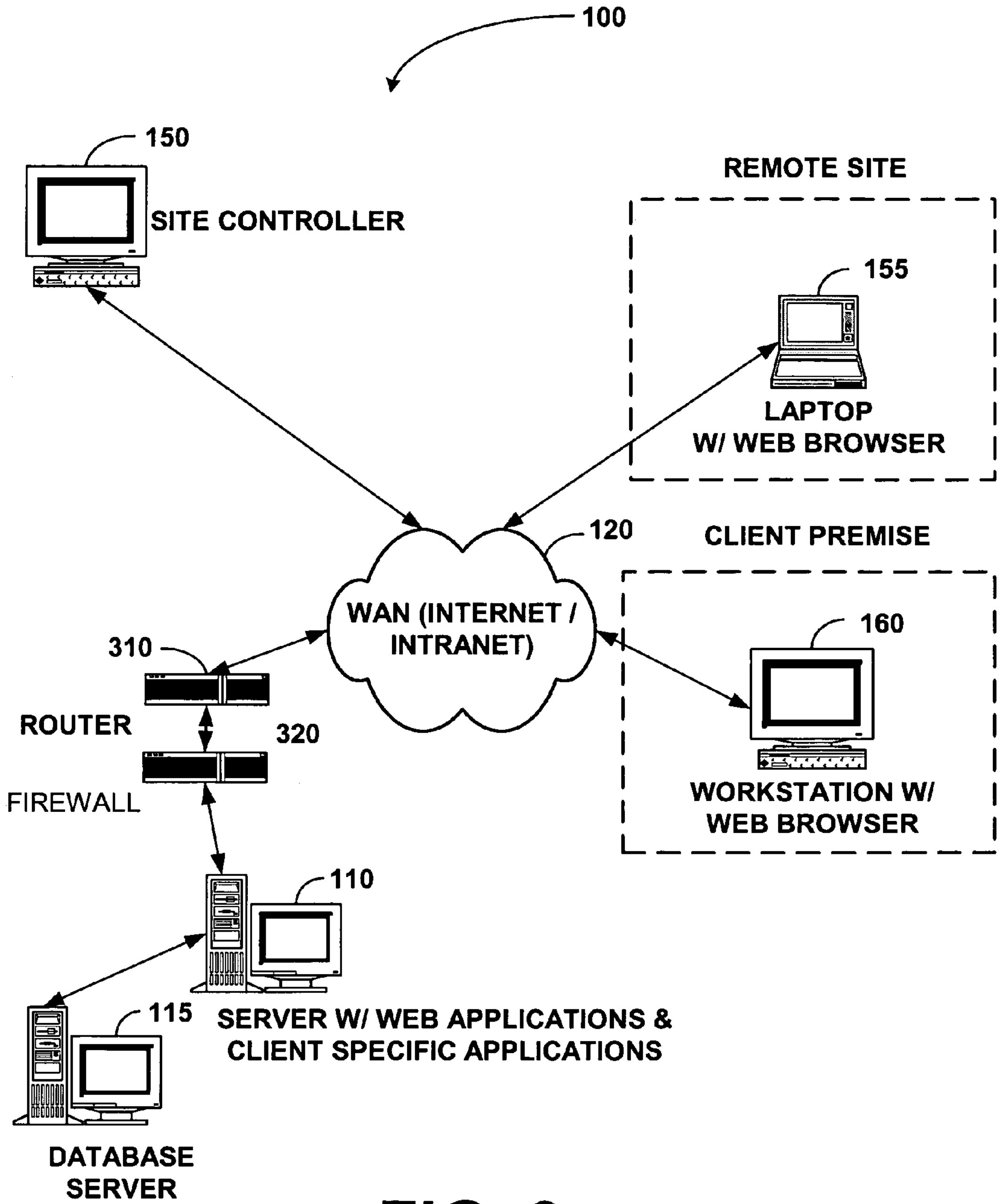

100
150
SITE CONTROLLER
REMOTE SITE
155
LAPTOP
W/ WEB BROWSER
120
CLIENT PREMISE
WAN (INTERNET / INTRANET)
310
ROUTER
320
FIREWALL
160
WORKSTATION W/
WEB BROWSER
110
115
SERVER W/ WEB APPLICATIONS &
CLIENT SPECIFIC APPLICATIONS
DATABASE
SERVER

FIG. 3

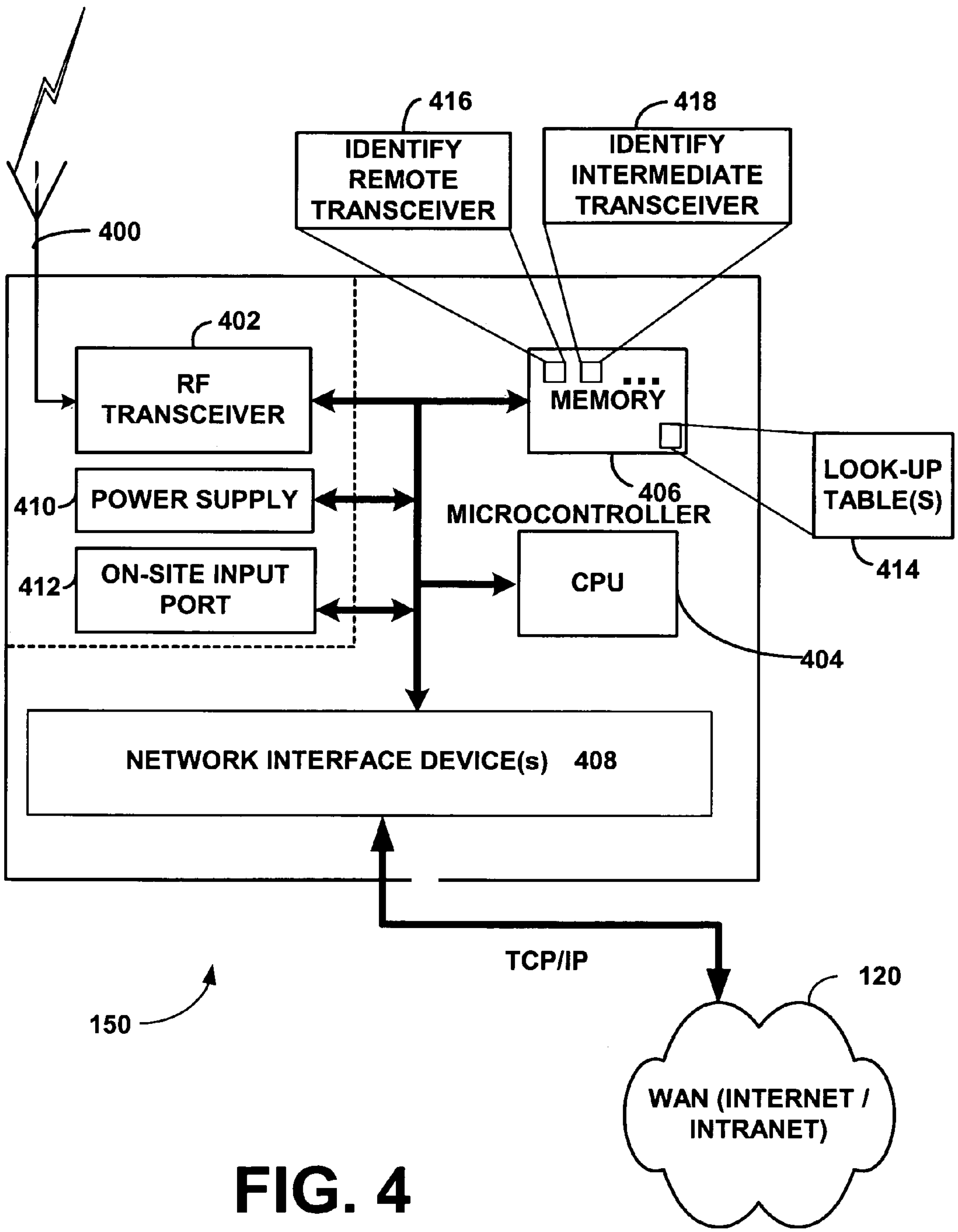
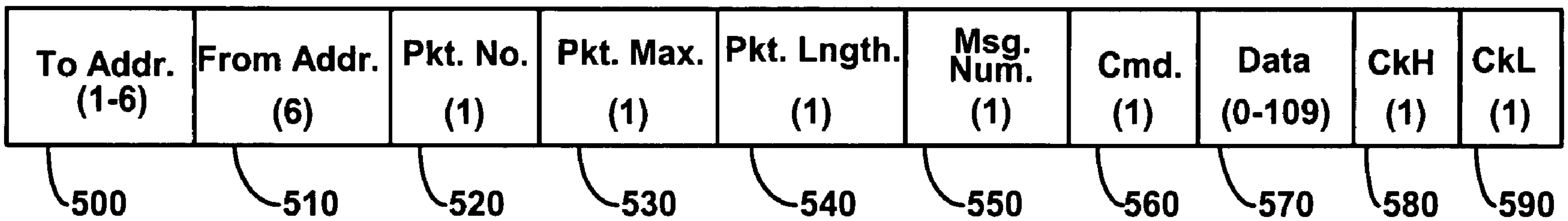

416
IDENTIFY REMOTE TRANSCEIVER
418
IDENTIFY INTERMEDIATE TRANSCEIVER
400
402
RF TRANSCEIVER
MEMORY
406
410
POWER SUPPLY
MICROCONTROLLER
LOOK-UP TABLE(S)
414
412
ON-SITE INPUT PORT
CPU
404
NETWORK INTERFACE DEVICE(s) 408
TCP/IP
120
150
WAN (INTERNET / INTRANET)

FIG. 4

FIG. 5 Message Structure



"To Address"	Byte Assignment:
MSB - Byte 1 Device Type	FF-F0 (16) - Broadcast All Devices (1 Byte Address) EF-1F (224) - Device Type Base (2 to 6 Byte Address) 0F-00 (16) - Personal Transceiver Identification (6 Byte Address)
Byte 2 Mfg./Owner ID	FF-F0 (16) - Broadcast all Devices (Byte 1 Type) (2 Byte Broadcast Address) EF-00 (240) - Mfg./Owner Code Identification Number
Byte 3 Mfg./Owner Extension ID	FF-F0 (16) - Broadcast all Devices (Byte 1 & Byte 2 Type) (3 Byte Broadcast Address) EF-00 (240) - Device Type/Mfg./Owner Code ID Number
Byte 4	FF-F0 (16) - Broadcast all Devices (Byte 1 & Byte 2 Type) (4 Byte Broadcast Address) EF-00 (240) - ID Number
Byte 5	(FF-00) 256 - Identification Number
Byte 6	(FF-00) 256 - Identification Number

FIG. 6

Sample Messages

Central Server to Personal Transceiver - Broadcast Message - FF (Emergency)

Byte Count = 12

700

To Addr.	From Addr.	Pkt. No.	Pkt. Max.	Pkt. Lngth.	Cmd.	CkH	CkL
(FF)	(12345678)	(00)	(00)	(0C)	(FF)	(02)	(9E)

First Transceiver to Repeater (Transceiver)
Broadcast Message - FF (Emergency)

Byte Count = 17

702

To Addr.	From Addr.	Pkt. No.	Pkt. Max.	Pkt. Lngth.	Cmd.	Data	CkH	CkL
(F0)	(12345678)	(00)	(00)	(11)	(FF)	(A000123456)	(03)	(A0)

Note: Additional Transceiver Re-Broadcasts do not change the message.
The messages are simply received and re-broadcast.

Message to Device "A0" From Device "E1" Command - "08" (Respond to PING)
Response will reverse "To" and "From" Addresses

704

Byte Count = 17

To Addr.	From Addr.	P #	P Max.	P Lngth.	Cmd.	Data	CkH	CkL
(A012345678)	(E112345678)	(00)	(00)	(11)	(08)	(A5)	(04)	(67)

FIG. 7

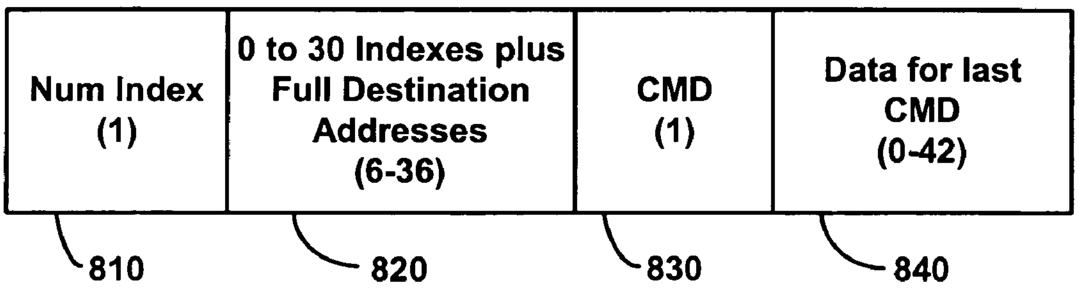

Num Index
(1)
0 to 30 Indexes plus
Full Destination
Addresses
(6-36)
CMD
(1)
Data for last
CMD
(0-42)
810
820
830
840

FIG. 8

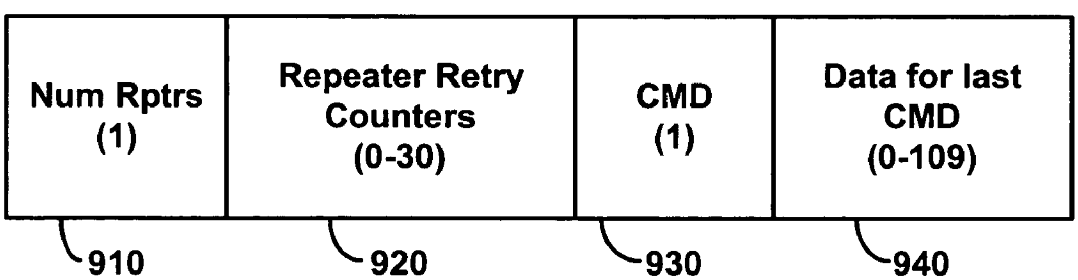
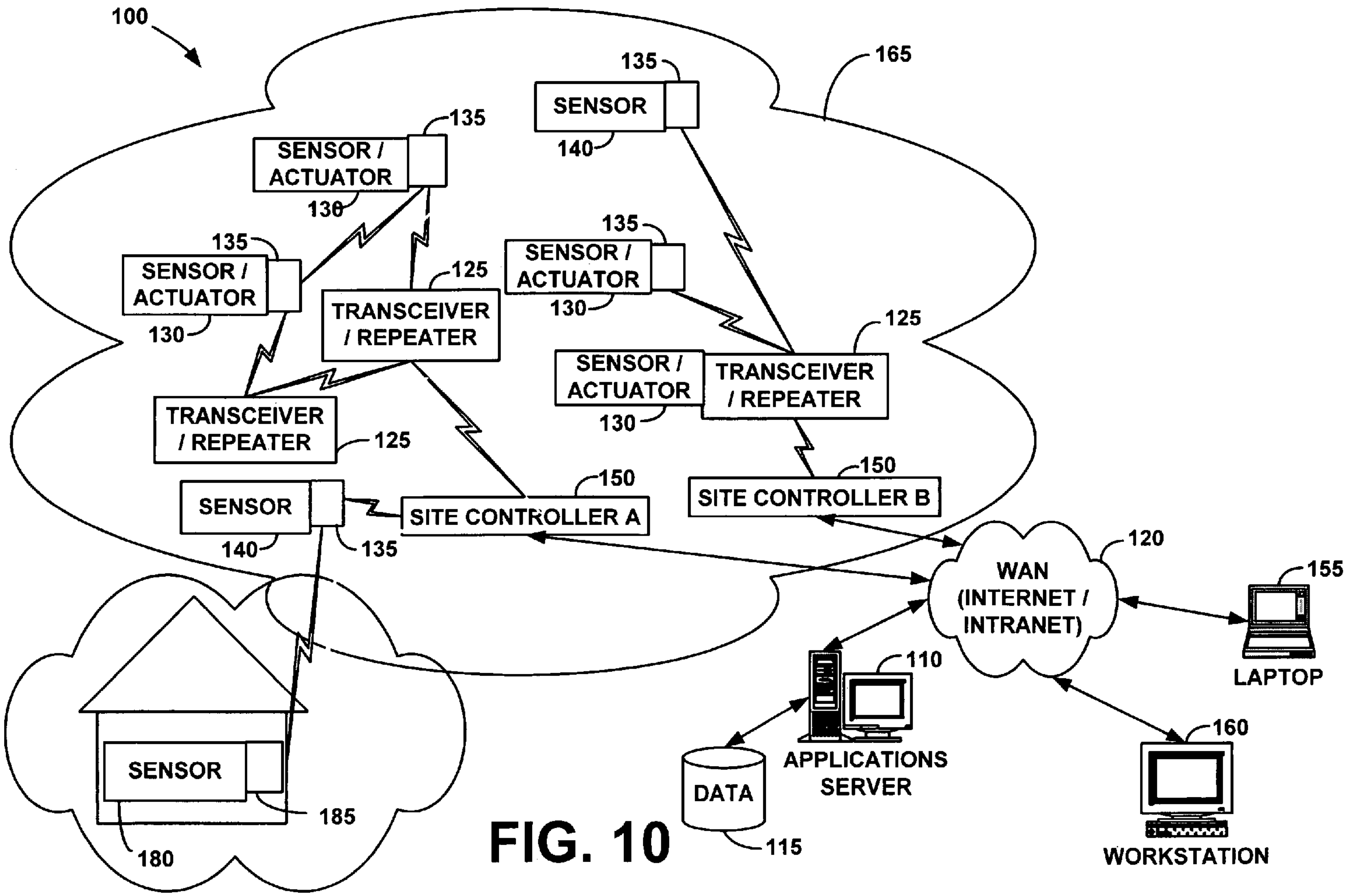

Num Rptrs
(1)
Repeater Retry
Counters
(0-30)
CMD
(1)
Data for last
CMD
(0-109)
910
920
930
940

FIG. 9



100
165
SENSOR
135
140
SENSOR / ACTUATOR
135
130
SENSOR / ACTUATOR
135
130
TRANSCEIVER / REPEATER
125
SENSOR / ACTUATOR
135
130
125
SENSOR / ACTUATOR
130
TRANSCEIVER / REPEATER
TRANSCEIVER / REPEATER
125
SENSOR
140
135
SITE CONTROLLER A
150
SITE CONTROLLER B
150
WAN (INTERNET / INTRANET)
120
LAPTOP
155
110
APPLICATIONS SERVER
DATA
115
WORKSTATION
160
SENSOR
180
185

FIG. 10

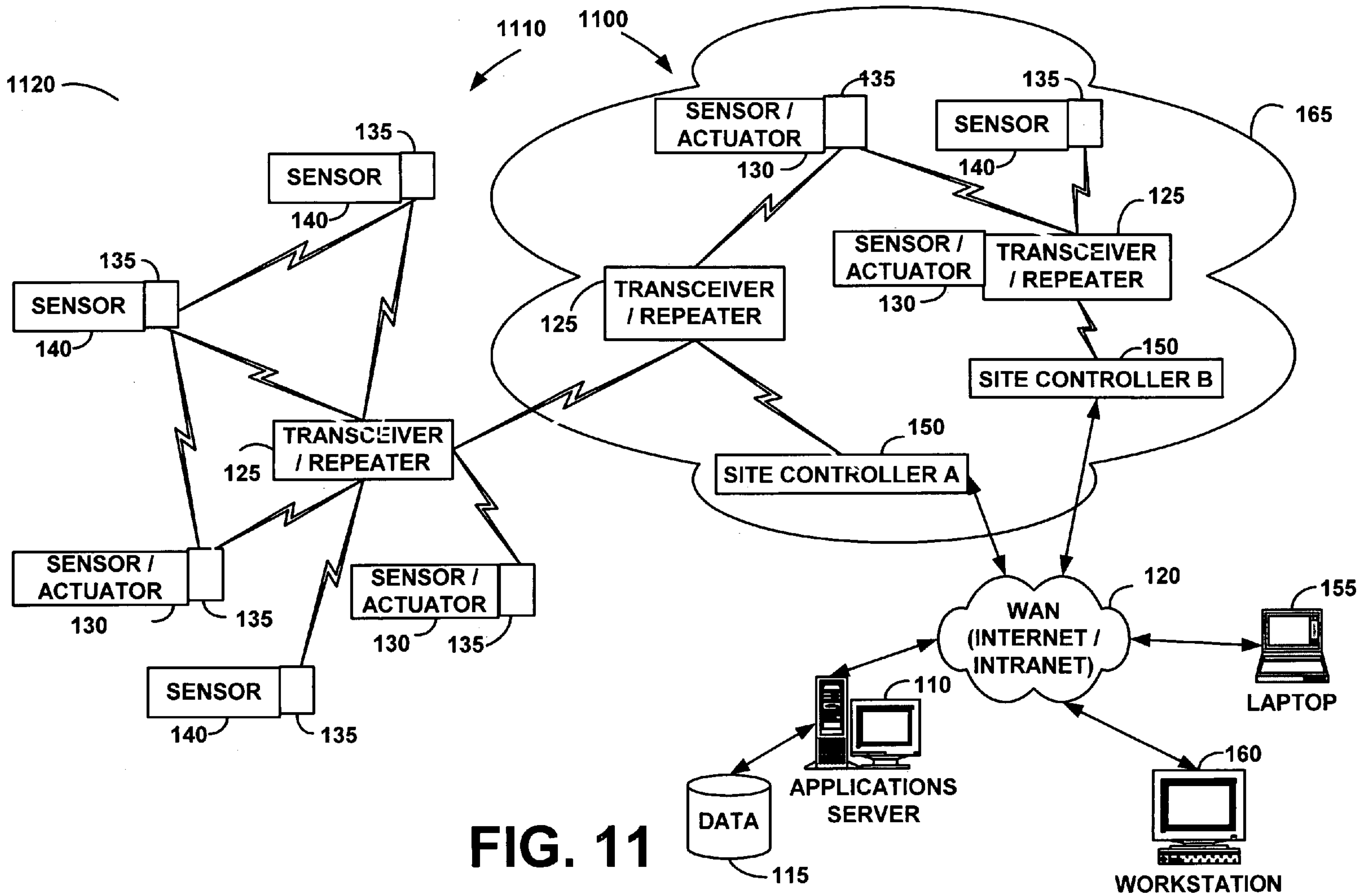

1120
1110
1100
165
135
SENSOR
140
SENSOR
SENSOR / ACTUATOR
130
TRANSCEIVER / REPEATER
125
SENSOR / ACTUATOR
SITE CONTROLLER A
150
SITE CONTROLLER B
WAN (INTERNET / INTRANET)
120
LAPTOP
155
APPLICATIONS SERVER
110
DATA
115
WORKSTATION
160

FIG. 11

WIRELESS COMMUNICATION NETWORKS FOR PROVIDING REMOTE MONITORING OF DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of the following U.S. utility patent applications: U.S. patent application Ser. No. 09/812,809, filed Mar. 20, 2001 now abandoned, and entitled "System and Method for Monitoring the Light Level in a Lighted Area," which is a continuation-in-part of U.S. patent application Ser. No. 09/412,895, filed Oct. 5, 1999 now U.S. Pat. No. 6,218,953, and entitled, "System and Method for Monitoring the Light Level Around an ATM," which is a continuation-in-part of U.S. patent application Ser. No. 09/172,554, filed Oct. 14, 1998 now U.S. Pat. No. 6,028,522, and entitled "System for Monitoring the Light Level Around an ATM;" U.S. patent application Ser. No. 09/271,517, filed Mar. 18, 1999 now abandoned, and entitled, "System For Monitoring Conditions in a Residential Living Community;" and U.S. patent application Ser. No. 09/439,059, filed Nov. 12, 1999 now U.S. Pat. No. 6,437,692, and entitled, "System and Method for Monitoring and Controlling Remote Devices." Each of the identified U.S. patent applications is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention generally relates to systems for monitoring and/or controlling a plurality of remote devices via a host computer connected to a wide area network (WAN), and more particularly relates to systems and methods for managing communication between the host computer and the plurality of remote devices.

BACKGROUND OF THE INVENTION

There are a variety of systems for monitoring and/or controlling any of a number of systems and/or processes, such as, for example, manufacturing processes, inventory systems, emergency control systems, personal security systems, residential systems, and electric utility meters to name a few. In many of these "automated monitoring systems," a host computer in communication with a wide area network monitors and/or controls a plurality of remote devices arranged within a geographical region. The plurality of remote devices typically use remote sensors and controllers to monitor and respond to various system parameters to reach desired results. A number of automated monitoring systems use computers or dedicated microprocessors in association with appropriate software to process system inputs, model system responses, and control actuators to implement corrections within a system.

Various schemes have been proposed to facilitate communication between the host computer and the remote devices within the system, including RF transmission, light transmission (including infra-red), and control signal modulation over the local power distribution network. For example, U.S. Pat. No. 4,697,166 to Warnagiris et al. describes a power-line carrier backbone for inter-element communications. As recognized in U.S. Pat. No. 5,471,190 to Zimmerman, there is a growing interest in home automation systems and products that facilitate such systems. One system, critically described in the Zimmerman patent, is the X-10 system. Recognizing that consumers will soon demand interoperability between household systems, appliances, and computing devices, the Electronics Industry Association (EIA) has adopted an industry standard, known as the Consumer Electronics Bus (CEBus). The CEBus is designed to provide reliable communications between suitably configured residential devices through a multi-transmission media approach within a single residence.

One problem with expanding the use of control systems technology to distributed systems is the cost associated with developing the local sensor-actuator infrastructure necessary to interconnect the various devices. A typical approach to implementing control system technology is to install a local network of hard-wired sensors and actuators along with a local controller. Not only is there expense associated with developing and installing appropriate sensors and actuators, but the added expense of connecting functional sensors and actuators with the local controller is also problematic. Another prohibitive cost is the expense associated with the installation and operational expense associated with programming the local controller.

Accordingly, an alternative solution for implementing a distributed control system suitable for monitoring and controlling remote devices that overcomes the shortcomings of the prior art is desired.

SUMMARY OF THE INVENTION

The present invention provides wireless communication networks for providing remote monitoring of devices. One embodiment of the present invention is generally directed to a cost-effective automated monitoring system and method for monitoring and controlling a plurality of remote devices via a host computer connected to a communication network, such as a wide area network. The automated monitoring system may include one or more sensors to be read and/or actuators to be controlled, ultimately, through a remote applications server via a site controller. The remote applications server and the site controller may communicate via a communication network, such as a wide area network. The sensors and/or actuators are in communication with a plurality of wireless transceivers, which define a primary wireless communication network. The wireless transceivers may transmit and/or receive encoded data and control signals to and from the site controller. Additional communication devices, such as wireless repeaters, may relay information between the wireless transceivers disposed in connection with the sensors and/or actuators and the site controller.

The present invention may be viewed as a wireless communication network adapted for use in an automated monitoring system for monitoring and controlling a plurality of remote devices via a host computer connected to a wide area network. Briefly, in one embodiment, the wireless communication network may comprise a plurality of wireless transceivers having unique identifiers and a site controller. Each of the plurality of wireless transceivers may be configured to receive a sensor data signal from one of the plurality of remote devices and transmit an original data message using a predefined wireless communication protocol. The original data message may comprise the corresponding unique identifier and sensor data signal. Each of the plurality of wireless transceivers may be further configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data message using the predefined communication protocol. The repeated data message may include the sensor data signal and the corresponding unique identifier. The site controller in communication with at least one of the plurality of wireless transceivers may be configured to: receive the original data messages and the repeated data messages; identify the remote device associated with the corresponding sensor data signal; and provide information related to the sensor data signal to the wide area network for delivery to the host computer.

The present invention may also be viewed as a wireless communication network for monitoring and controlling a plurality of remote devices. Briefly, in one embodiment, the wireless communication network may comprise a plurality of wireless transceivers having unique identifiers. Each of the plurality of wireless transceivers may be configured to receive a sensor data signal from one of the plurality of remote devices and transmit an original data message using a predefined wireless communication protocol. The original data message may comprise the corresponding unique identifier and sensor data signal. Each of the plurality of wireless transceivers may be configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data message using the predefined communication protocol. The repeated data message may include the sensor data signal and the corresponding unique identifier. Furthermore, at least one of the plurality of wireless transceivers may be further configured to provide the original data messages and the repeated data messages to a site controller connected to a wide area network. The site controller may be configured to manage communications between the wireless communication network and a host computer connected to the wide area network.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings incorporated in and forming a part of the specification, illustrate several aspects of the present invention, and together with the description serve to explain the principles of the invention. The components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is a block diagram illustrating an embodiment of an automated monitoring system according to the present invention.

FIG. **2** is a block diagram of one of a number of embodiments of a transceiver of FIG. **1** in communication with a sensor of FIG. **1**.

FIG. **3** is a more detailed schematic diagram illustrating the connectivity of the WAN of FIG. **1**.

FIG. **4** is a block diagram illustrating one of a number of possible embodiments of the site controller of FIG. **1**.

FIG. **5** is a table illustrating an embodiment of a message structure for a communication protocol according to the present invention that may be used for communicating between the site controller and transceivers of FIG. **1**.

FIG. **6** is a table illustrating various values for the "to address" in the message structure of FIG. **5**.

FIG. **7** illustrates three sample messages for the message structure of FIG. **5** according to the present invention.

FIG. **8** is a table illustrating the data section of a downstream message in accordance with the message protocol of FIG. **5**.

FIG. **9** is a table illustrating the data section of an upstream message in accordance with the message protocol of FIG. **5**.

FIG. **10** is a block diagram illustrating another embodiment of the automated monitoring system according to the present invention.

FIG. **11** illustrates an automated monitoring network **1100** according to the present invention for enabling multiple groups of remote devices associated with multiple wireless communication networks to be monitored and/or controlled via a common connection to a wide area network.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Having summarized the invention above, reference is now made in detail to the description of the invention as illustrated in the drawings. While the invention will be described in connection with these drawings, there is no intent to limit it to the embodiment or embodiments disclosed therein. On the contrary, the intent is to cover all alternatives, modifications and equivalents included within the spirit and scope of the invention as defined by the appended claims.

FIG. **1** is a block diagram illustrating one of a number of possible embodiments of an automated monitoring system **100** according to the present invention. Automated monitoring system **100** may comprise one or more applications servers **110**, a database **115**, a wide area network (WAN) **120**, transceivers/repeaters **125**, sensor/actuators **130**, transceivers **135**, sensors **140**, transmitters **145**, and at least one site controller **150**. Each of the sensor/actuators **130** and sensors **140** is integrated with a suitably configured wireless transceiver/repeater **125**, a wireless transceiver **135**, or wireless transmitter **145**. Within the context of this document, a wireless transceiver/repeater **125**, a wireless transceiver **135**, and a wireless transmitter **145** will be referred to as "wireless communication devices."

Each of the wireless communication devices in automated monitoring system **100** is preferably small in size and may be configured to transmit a relatively low-power signal, such as, for example a radio frequency (RF) signal. As a result, in some applications, the transmission range of a given RF communication device may be relatively limited. Of course, the transmitter power and range may be appropriately designed for the target operating environment. As will be appreciated from the description that follows, this relatively limited transmission range of the wireless communication devices is advantageous and a desirable characteristic of automated monitoring system **100**. Although the wireless communication devices are depicted without a user interface such as a keypad, etc., in certain embodiments the wireless communication devices may be configured with user selectable pushbuttons, switches, an alphanumeric keypad, or any other type of user interface device suitably configured with software and/or firmware to accept operator input. Often the wireless communication device will be in communication with a sensor **140** or with a sensor/actuator **130**, such as a smoke detector, a thermostat, a security system, etc., where user selectable inputs may not be needed.

As illustrated in FIG. **1**, the wireless communication devices in automated monitoring system **100** are geographically arranged such that the antenna patterns (not shown) associated with each wireless communication device overlap to create a coverage area **165**. In this manner, automated monitoring system **100** may enable a site controller **150** associated with coverage area **165** to communicate with each sensor/actuator **130** and each sensor **140** via any of a plurality of possible communication paths. For instance, site controller **150** may communicate with a specific sensor/actuator **130** via a plurality of distinct communication paths, each of which are defined by one or more wireless communication devices involved in the communication between site controller **150** and the specific sensor/actuator **130**. By way of example, one of the plurality of possible communication paths may consist of a wireless connection from site controller **150** to a wireless communication device associated with the specific sensor/actuator **130**. Another possible communication path may consist of a wireless connection from site controller **150** to an intermediate wireless communication device and then to the wireless communication device associated with the specific sensor/actuator **130**. Further communication paths may include multiple intermediate wireless communication devices in the wireless connection between site controller **150** and the wireless communication device associated with the specific sensor/actuator **130**.

As illustrated in FIG. **1**, one or more sensors **140** may communicate with at least one site controller **150** via a wireless transmitter **145**, a wireless transceiver **135**, or a wireless transceiver/repeater **125**. Furthermore, one or more sensors/actuators **130** may communicate with at least one site controller **150** via a wireless transceiver **135** or a wireless transceiver/repeater **125**. One of ordinary skill in the art will appreciate that in order to send a command from the applications server **110** to a sensor/actuator **130**, the wireless communication device associated with the sensors/actuators **130** should be a two-way communication device, such as a transceiver. It will also be appreciated that one or more sensors/actuators **130** may be in direct communication with one or more site controllers **150**. It will be further appreciated that the communication medium between the one or more sensor/actuators **130** and the one or more site controller **150** may be wireless or, for relatively closely located configurations, a wired communication medium may be used.

As is further illustrated in FIG. **1**, automated monitoring system **100** may comprise a plurality of stand-alone wireless transceiver/repeaters **125**. Each stand-alone wireless transceiver/repeater **125**, as well as each wireless transceiver **135**, may be configured to receive one or more incoming transmissions (transmitted by a remote transmitter **145** or transceiver **135**) and to transmit an outgoing signal. This outgoing signal may be any wireless transmission signal, such as, for example, a low-power RF transmission signal, or a higher-power RF transmission signal. Alternatively, where a wired configured is employed, the outgoing signal may be transmitted over a conductive wire, fiber optic cable, or other transmission media. One of ordinary skill in the art will appreciate that if an integrated wireless communication device (e.g., a wireless transmitter **145**, a wireless transceiver **135**, or a wireless transceiver/repeater **125**) is located sufficiently close to site controller **150** such that its output signal can be received by at least one site controller **150**, the data transmission signal need not be processed and repeated through either a wireless transceiver/repeater **125** or wireless transceivers **135**.

One or more site controllers **150** are configured and disposed to receive remote data transmissions from the various stand-alone wireless transceiver/repeaters **125**, integrated wireless transmitters **145**, or the integrated wireless transceivers **135**. The site controllers **150** may be configured to analyze the transmissions received, convert the transmissions into TCP/IP format, and further communicate the remote data signal transmissions via WAN **120** to one or more applications servers **110** or other devices in communication with WAN **120**. One of ordinary skill in the art will appreciate that additional site controllers **150** may function as either a back-up site controller in the event of a site controller failure or can function as a primary site controller to expand the potential size of coverage area **165** of automated monitoring system **100**. When implemented as a back-up site controller **150**, the second site controller **150** may function when the applications server **110** detects a site controller failure. Alternatively, the second site controller **150** may function to expand the capacity of automated monitoring system **100**. A single site controller **150** may accommodate a predetermined number of wireless communication devices. While the number of wireless communication devices may vary based upon individual requirements, in one of a number of embodiments there may be approximately 500 wireless communication devices.

By way of example, a second site controller **150** may double the capacity of a single system. Although not shown, additional site controllers **150** may be added depending on the specific implementation of automated monitoring system **100**. The number of wireless communication devices managed by a site controller **150** is limited only by technical constraints such as memory, storage space, etc. In addition, the site controller **150** may manage more addresses than devices as some wireless communication devices may have multiple functions such as sensing, repeating, etc. As stated above, automated monitoring system **100** includes an applications server **110** in communication with site controller **150** via WAN **120**. Applications server **110** may host any of a variety of application specific software depending on the precise environment in which automated monitoring system **100** is employed. As further described below, the site controller **150** may receive, via WAN **120**, information in the form of data and/or control signals from applications server **110**, laptop computer **155**, workstation **160**, and any other device in communication with WAN **120**. Site controller **150** may then communicate the data and/or control signals to remote sensor/actuators **130** and/or remote sensors **140**. Automated monitoring system **100** may also comprise a database **115** associated with applications server **110**. Database **115** may be configured to communicate with applications server **110** and record client specific data or to assist the applications server **110** in deciphering a particular data transmission from a particular sensor **140**, sensor/actuator **130**, etc.

Reference is now made to FIG. **2**, which is a block diagram illustrating a transceiver **135** that may be integrated with a sensor **140**, sensor/actuator **130**, etc. As stated above, the characteristics of sensor **130** may vary depending on the environment in which automated monitoring system **100** is implemented. For example, the sensor **130** may be a two-state device such as a smoke alarm, a thermometer, a utility meter, a personal security system controller, or any other sensor. Regardless the specific characteristics of sensor **130**, transceiver **135** may include a data interface **205** configured to receive and/or transmit signal to sensor **130**. If the signal output from the sensor **130** is an analog signal, the data interface **205** may include an analog-to-digital converter (not shown) to convert the signals. Alternatively, where transceiver **135** and sensor **130** communicate using digital signals, transceiver **135** may include a digital interface (not shown) that communicates with the data interface **205** and the sensor **130**.

As illustrated in FIG. **2**, the sensor **140** may be in communication with the transceiver **135**. Transceiver **135** may comprise an RF transceiver controller **210**, a data interface **205**, a microcontroller **215**, a memory **220**, and an antenna **225**. A data signal forwarded from the sensor **140** may be received by the data interface **205**. In those situations where the data interface **205** has received an analog data signal, the data interface **205** may be configured to convert the analog signal into a digital signal before forwarding a digital representation of the data signal to the data controller **215**. In one embodiment, each transceiver **135** may be configured with a memory **220** that stores a unique transceiver identifier that identifies the RF transceiver **135**.

Transceivers **135** that function in automated monitoring system **100** as both a repeater and an integrated transceiver have two unique addresses. One address indicates messages intended for the repeater; the second address indicates messages for the sensor **140**. Data controller **215** evaluates the incoming message to determine which address the message contains, which function is desired, and acts accordingly.

In operation, the RF transceiver **135** receives an incoming message via antenna **225**. The transceiver controller **210** receives the incoming message, modifies the received signal, and passes the modified signal onto the microcontroller **215**. The microcontroller **215** evaluates the message to determine the intended recipient.

If the intended recipient is the integrated transceiver **135**, the microcontroller **215** then prepares the appropriate response as discussed below. This response may include data from the sensor **140**. If the intended recipient is the repeater, the microcontroller **215** then prepares the message to be repeated onto the intended recipient according to the message protocol discussed below.

Of course, additional and/or alternative configurations may also be provided by a similarly configured transceiver **135**. For example, a similar configuration may be provided for a transceiver **135** that is integrated into, for example, a carbon monoxide detector, a door position sensor, etc. Alternatively, system parameters that vary across a range of values may be transmitted by transceiver **135** as long as data interface **205** and microcontroller **215** are configured to apply a specific code that is consistent with the input from sensor **140**. Automated monitoring system **100** may enable the target parameter to be monitored. The transceiver **135** may be further integrated with an actuator (not shown). This provides the ability to remotely control systems such as HVAC systems, lighting systems, etc. via the applications server **110** (FIG. **1**). Further information regarding use of actuators in automated monitoring system **100** may be found in commonly assigned U.S. patent application Ser. No. 09/811,076, entitled "System and Method for Monitoring and Controlling Remote Devices," and filed Mar. 16, 2001, which is hereby incorporated in its entirety by reference.

One of ordinary skill in the art will appreciate that the various communication devices in automated monitoring system **100** may be configured with a number of optional power supply configurations. For example, a personal mobile transceiver may be powered by a replaceable battery. Similarly, a repeater may be powered by a replaceable battery that may be supplemented and/or periodically charged via a solar panel. These power supply circuits, therefore, may differ between communication device depending upon the devices being monitored, the related actuators to be controlled, the environment, and the quality of service required. In the case of a transceiver acting as both a repeater and a remote monitoring device, the transceiver may be independently powered so as not to drain the sensor or actuator. Those skilled in the art will appreciate how to meet the power requirements of the various communication devices. As a result, it is not necessary to further describe a power supply suitable for each communication device and each application in order to appreciate the concepts and teachings of the present invention.

As stated above, automated monitoring system **100** may be used in a variety of environments to monitor and/or control any of a variety of types of sensors **140** and sensors/actuators **130**. Regardless of the particular environment and the type of remote device employed in automated monitoring system **100**, transceiver **135** may further comprise logic configured to receive data from sensor **140** and/or sensor/actuator **130**, retrieve the unique identifier from memory **220**, and generate a transmit message using a predefined communication protocol being implemented by the wireless communication network, which is described in detail below. Nonetheless, one of ordinary skill in the art will appreciate that various other communication protocols may be used in accordance with the present invention.

Depending on the specific implementation of sensor **140** and/or sensor/actuator **130**, the data may be formatted in a variety of ways. For example, as stated above, the data received by data interface **205** may be an analog or a digital signal. Regardless the specific configuration of sensor **140** and/or sensor/actuator **130**, data interface **205** is configured to receive the sensor data.

The transmit message generated may comprise the unique identifier stored in memory **220** and the sensor data. As described above, the transmit message may be formatted in the message structure described below. More importantly, the transmit message may be configured such that the transmit message may be received by the site controller **150** via the wireless communication network and such that the site controller **150** may identify the sensor **140** and/or sensor/actuator **130** and notify applications server **110** of the transmit message.

One of ordinary skill in the art will appreciate that the logic described above, may be implemented in hardware, software, firmware, or a combination thereof. As illustrated in FIG. **2**, in one of a number of possible embodiments, the logic is implemented in software or firmware that is stored in memory **220** and that is executed by microcontroller **215**. If implemented in hardware, as in alternative embodiments, the logic may be implemented in any one or combination of volatile memory elements (e.g., random access memory (RAM, such as DRAM, SRAM, SDRAM, etc.)) and nonvolatile memory elements (e.g., ROM, hard drive, tape, CDROM, etc.). Memory **220** may incorporate electronic, magnetic, optical, and/or other types of storage media. Memory **220** may also have a distributed architecture, where various components are situated remote from one another. If implemented in hardware, as in alternative embodiments, the logic may be implemented with any or a combination of the following technologies, which are all well known in the art: a discrete logic circuit(s) having logic gates for implementing logic functions upon data signals, an application specific integrated circuit (ASIC) having appropriate combinational logic gates, a programmable gate array(s) (PGA), a field programmable gate array (FPGA), etc.

Furthermore, one of ordinary skill in the art will appreciate that the integration of sensor **140** and/or sensor/actuator **130** and transceiver **135** may be accomplished in a variety of ways. For example, in one embodiment, transceiver **135** may be included within sensor **140** and/or sensor/actuator **130** as part of its internal configuration. In other embodiments, transceiver **135** may be externally attached to sensor **140** and/or sensor/actuator **130**. In further embodiments, transceiver **135** may be installed in close proximity to sensor **140** and/or sensor/actuator **130** such that transceiver **135** and sensor **140** and/or sensor/actuator **130** communicate via a wired or wireless connection.

Referring again to FIG. **2**, during normal operation, transceiver **135** may receive a command message on antenna **225** via a message protocol. The command message may be initiated from site controller **150**, applications server **110**, laptop **155**, workstation **160**, or any other device connected to WAN **120**. In this manner, the command message may be used to request data related to the electricity consumption of a particular electric meter (i.e., sensor **104**, sensor/actuator **135**). Microcontroller **215** may evaluate the received message to determine if the "to" address is its own unique address. If it is, then the microcontroller **215** evaluates the command and prepares a response message.

In response to the command message, microcontroller **215** receives the senosr data related to the sensor **140** and/or sensor/actuator **130**. In one embodiment, the sensor data may be retrieved by initiating a request to the sensor **140** and/or sensor/actuator **130**. In another embodiment, the data may be stored in memory **220**, in which case microcontroller **215** retrieves the data from memory **220**. Microcontroller **215** may also retrieve the unique address from memory **220**. Then, the microcontroller **215** formats a transmit signal in response to the command message as described above. Microcontroller **215** then communicates the transmit signal to transceiver controller **210**, which provides the transmit signal to the wireless communication network. The transmit signal may be delivered to the site controller **150**. Depending on where the command message was generated, the transmit signal may be forwarded to applications server **110**, laptop **155**, workstation **160**, a computing device operated by a user, or any other device connected to WAN **120**.

Of course, additional and/or alternative configurations may also be provided by a similarly configured transceiver. For example, a similar configuration may be provided for a transceiver that is integrated into, for example, a carbon monoxide detector, a door position sensor, etc. Alternatively, system parameters that vary across a range of values may be transmitted by transceiver **135** as long as data interface **205** and microcontroller **215** are configured to apply a specific code that is consistent with the input from sensor **140**. As long as the code is known by the application server **110** or workstation **160**, the target parameter may be monitored with the present invention. The RF transceiver **135** may be further integrated with an actuator. This would provide the user with the ability to remotely control systems such as HVAC systems, lighting systems, etc. remotely via the applications server **110**. Further information regarding the integration of an actuator can be found in Ser. No. 09/811,076, "System and Method for Monitoring and Controlling Remote Devices," filed Mar. 16, 2001, commonly assigned and incorporated in its entirety herein by reference.

Reference is now made to FIG. **3**, which illustrates the external connectivity of WAN **120** of FIG. **1** in accordance with the present invention. Site controller **150** may be configured to transmit control signals and receive data signals using the open data packet protocol described in detail below. Site controller **150** is preferably interconnected permanently on WAN **120** and configured to receive data signals from the wireless communication devices and translate the data signals for transfer to applications servers **110** via WAN **120**. Site controller **150** may translate the received data signals into any appropriate protocol for delivery via WAN **120**. For example, in one embodiment site controller **150** translates the received data signals into transmission control protocol/Internet protocol (TCP/IP) for delivery via WAN **120**. As stated above, applications server **110** may be configured for communication with WAN **120** via, for example, router **310** and further protected and buffered by firewall **320**. Applications server **110** may also configured with web applications and client specific applications as needed for operation of automated monitoring system **100**. Consistent with the concepts and teachings of the present invention, applications server **110** may be assisted in its task of storing and making available client specific data by database **115**.

As further illustrated in FIG. **3**, a client workstation **160** may include a Web browser for facilitating communication with applications server **110**, database **115**, and/or site controller **150**. Alternatively, clients may access WAN **120** via a remote laptop **155** or other computing devices (not shown) configured with a compatible Web browser or other user interface. In this way, the applications server **110** may provide client specific data upon demand.

As stated above, communication between site controller **150** and sensors/actuators **130** and sensors **140** is accomplished using an open data packet protocol in accordance with the present invention. Because the wireless communication devices are geographically arranged such that their respective antenna patterns overlap to create a coverage area **165**, site controller **150** may communicate with each sensor/actuator **130** and each sensor **140** via any of a plurality of possible communication paths. Each of the communication paths are defined by one or more wireless communication devices involved in the communication between site controller **150** and the target sensor/actuator **130** and/or sensor **140**. For instance, site controller **150** may communicate with a specific sensor/actuator **130** via a plurality of distinct communication paths. By way of example, one of the plurality of possible communication paths may consist of a wireless connection from site controller **150** to a wireless communication device associated with the specific sensor/actuator **130**. Another possible communication path may consist of a wireless connection from site controller **150** to an intermediate wireless communication device and then to the wireless communication device associated with the specific sensor/actuator **130**. Further communication paths may include multiple intermediate wireless communication devices in the wireless connection between site controller **150** and the wireless communication device associated with the specific sensor/actuator **130**. In this manner, site controller **150** may communicate with sensors/actuators **130** and/or sensors **140** that are located a greater distance from the site controller **150** by having messages repeated by successive wireless communication devices along one of the communication paths.

Having illustrated and described the operation of the various combinations of communication devices with the sensor **140** and sensor/actuators **130** (FIG. **1**), reference is now made to FIG. **4**, which is a block diagram further illustrating one embodiment of a site controller **150**. A site controller **150** may comprise an antenna **400**, an RF transceiver **402**, a central processing unit (CPU) **404**, memory **406**, a network interface device, such as a network card **425**, a digital subscriber line (DSL) modem, an integrated services digital network (ISDN) interface card, as well as other components not illustrated in FIG. **4**, which may be configured to enable a TCP/IP connection to the WAN **120** (FIG. **1**). Site controller **150** may also include a power supply **410** for powering the site controller **150**. The power supply **410** may be one of many known power supplies. In addition, the site controller **150** may include an on-site input port **412**, which allows a technician to communicate directly with site controller **150**. Further information regarding the function, operation, and architecture of the site controller **150** may be found in commonly assigned U.S. patent application "System and Method for Controlling Communication Between a Host Computer and Communication Devices Associated with Remote Devices in an Automated Monitoring System," (Ser. No. 09/925,786) which is hereby incorporated in its entirety by reference.

The RF transceiver **402** may be configured to receive incoming transmissions via the antenna **400**. Each of the incoming transmissions are consistently formatted in the message protocol as described below. The site controller **150** may be configured such that the memory **406** includes a look-up table **414** configured for identifying the various remote and intermediate communication devices used in generating and transmitting the received data transmission. As illustrated in FIG. **4**, site controller **150** may include an "Identify Remote Transceiver" memory sector **416** and "Identify Intermediate Transceiver" memory sector **418**. Programmed or recognized codes within memory **406** may also be provided and configured for controlling the operation of a CPU **404** to carry out the various functions that are orchestrated and/or controlled by the site controller **150**. For example, memory **406** may include program code for controlling the operation of the CPU **404** to evaluate an incoming data packet to determine what action needs to be taken. In this regard, one or more look-up tables **414** may also be stored within the memory **406** to assist in this process. Furthermore, the memory **406** may be configured with program code configured to identify a remote transceiver or identify an intermediate RF transceiver. Function codes and RF transmitter and/or RF transceiver identifiers may all be stored with associated information within the look-up tables **414**.

Thus, one look-up table **414** may be provided to associate transceiver identifications with a particular user. Another look-up table **414** may be used to associate function codes associated with the message protocol. For example, a look-up table **414** may include a unique code designating various functions, such as test, temperature, smoke alarm active, security system breach, etc. In connection with the lookup table(s) **414**, the memory **406** may also include a plurality of code segments that are executed by the CPU **404**, which may in large part control operation of the site controller **150**. For example, a first data packet segment may be provided to access a first lookup table **414** to determine the identity of the transceiver that transmitted the received message. A second code segment may be provided to access a second lookup table to determine the proximate location of the transceiver that generated the message. A third code segment may be provided to identify the content of the message transmitted (not shown). Namely, is it a fire alarm, a security alarm, an emergency request by a person, a temperature control setting, etc. In accordance with the present invention, additional, fewer, or different code segments may be provided to carry out different functional operations and data signal transfers.

The site controller **150** may also include one or more network interface devices **408** to facilitate via WAN **120**. For example, the site controller **150** may include a network card, which may allow the site controller **150** to communicate across a local area network to a network server. This network server may function as a backup site controller **150** to the WAN **120**. Alternatively, the site controller **150** may contain a DSL modem, which may be configured to provide a link to a remote computing system by way of the public switched telephone network (PSTN). In yet another embodiment, the site controller **150** may include an ISDN card configured to communicate via an ISDN connection with a remote system. One of ordinary skill in the art will appreciate that various other communication interfaces may be provided to serve as primary and/or backup links to the WAN **120** (FIG. **1**) or to local area networks that might serve to permit local monitoring of the status of the site controller **150** and for data packet control.

Communication between the site controller **150** and the communication devices within coverage area **165** may be implemented using a data packet protocol according to the present invention. FIG. **5** sets forth one embodiment of a message structure for the data packet protocol of the present invention. Messages transmitted within the automated monitoring system **100** may consist of a "to" address **500**, a "from" address **510**, a packet number **520**, a number of packets in a transmission **530**, a packet length **540**, a message number **550**, a command number **560**, data **570** (if applicable), and a check sum error detectors (CKH **580** and CKL **590**).

The "to" address **500** indicates the intended recipient of the packet. This address can be scalable from one to six bytes based upon the size and complexity of automated monitoring system **100**. By way of example, the "to" address **500** may indicate a general message to all transceivers, to only the repeaters, or to a single integrated transceiver. In a six byte "to" address **500**, the first byte indicates the transceiver type—to all transceivers, to some transceivers, or a specific transceiver. The second byte may be the identification base, and bytes three through six may be used for the unique transceiver address (either stand-alone or integrated). The "to" address **500** may be scalable from one byte to six bytes depending upon the intended recipient(s).

The "from" address **510** identifies the transceiver originating the transmission and may be a six-byte unique address. The "from" address **510** may be the address of the site controller **150** (FIG. **1**) when the site controller **150** (FIG. **1**) requests data, or this may be the address of the integrated transceiver responding to a request for information from the site controller **150** (FIG. **1**).

The packet number **520**, the packet maximum **530**, and the packet length **540** may be used to concatenate messages that are greater than a predetermined length. The packet maximum **530** indicates the number of packets in the message. The packet number **520** may be used to indicate a packet sequence number for a multiple-packet message.

The message number **550** may be assigned by the site controller **150**. Messages originating from the site controller **150** may be assigned an even number, while responses to the site controller **150** may have a message number equal to the original message number plus one. Thus, the site controller **150** may increments the message number **550** by two for each new originating message. This may enable the site controller **150** to coordinate the incoming responses to the appropriate command message.

The command number **560** may designate a specific data request from the receiving device. One of ordinary skill in the art will appreciate that, depending on the specific implementation of automate monitoring system **100**, the types of commands may differ. In one embodiment, there may be two types of commands: device specific and non-device specific. Device specific commands may control a specific device such as a data request or a change in current actuator settings. Commands that are not device specific may include, but are not limited to, a ping, an acknowledge, a non-acknowledgement, downstream repeat, upstream repeat, read status, emergency message, and a request for general data to name a few. General data may include a software version number, the number of power failures, the number of resets, etc.

The data field **570** may contain data as requested by a specific command. The requested data may be any value. By way of example, test data can preferably be encoded in ASCII (American Standard Code for Information Interchange) or other known encoding systems as known in the art. The data field **570** of a single packet may be scalable up to a predetermined length. When the requested data exceeds the predetermined length, the data controller of transceiver **135** may divide the data into an appropriate number of sections and concatenates the series of packets for one message using the packet identifiers as discussed above.

While specific byte lengths for sections of the message are being set forth, it would be obvious to one of ordinary skill in the art to vary the byte lengths based upon system needs. Less complex systems, etc. could use smaller sized sections, whereas more complex systems could increase the byte lengths.

Checksum fields **580** and **590** may be used to detect errors in the transmissions. In one embodiment, any error can be detected via cyclic redundancy check sum methodology. This methodology treats the message as a large binary number and divides the binary number by a generating polynomial (such as CRC-16). The remainder of this division is then sent with the message as the checksum. The receiver then calculates a checksum using the same methodology and compares the two checksums. If the checksums do not match, the packet or message will be ignored. While this error detection methodology is preferred, one of ordinary skill in the art will appreciate that other error detection systems may be implemented.

As stated above, automated monitoring system **100** may employ wireless and/or wired communication technologies for communication between site controller **150** and the various communication devices. In one embodiment, communication between site controller **150** and the communication devices may be implemented via an RF link at a basic rate of 4,800 bits per second (bps) and a data rate of 2400 bps. All the data may be encoded in the Manchester format such that a high to low transition at the bit center point represents a logic zero and a low to high transition represents a logic one. One of ordinary skill in the art will appreciate that other RF formats may be used depending upon design needs. By way of example, a quadature phase shift encoding method may be used, thereby enabling automated monitoring system **100** to communicate via hexadecimal instead of binary.

While the message indicates specific byte length for each section, only the order of the specific information within the message is constant. The byte position number in individual transmissions may vary because of the scalability of the "to" address **500**, the command byte **560**, and the scalability of the data **570**.

The message may further include a preface and a postscript (not shown). The preface and postscripts are not part of the message body but rather serve to synchronize the control system and to frame each packet of the message. The packet begins with the preface and ends with a postscript. The preface may be a series of twenty-four logic ones followed by two bit times of high voltage with no transition. The first byte of the packet can then follow immediately. The postscript may be a transition of the transmit data line from a high voltage to a low voltage, if necessary. It may be less desirable to not leave the transmit data line high after the message is sent. It would be obvious to one of ordinary skill in the art to modify the preface and the postscript as necessary based on specific design needs.

FIG. **6** illustrates one embodiment of a byte assignment for the "to" address **500** of FIG. **5**. One of ordinary skill in the art will appreciate that various byte assignments may be used within "to" address field **500**. For example, in one embodiment, "to" address **500** consists of six bytes. The first byte (Byte **1**) may indicate the device type. The second byte (Byte **2**) may indicate the manufacturer or the owner. The third byte (Byte **3**) may be a further indication of the manufacturer or owner. The fourth byte (Byte **4**) may indicate either that the message is for all devices or that the message is for a particular device. If the message is for all devices, the fourth by may be a particular code. If the message is for a particular device, the fourth, fifth, and sixth bytes (Byte **5** and Byte **6**) may include the unique identifier for that particular device.

FIG. **7** illustrates three sample messages using the open data packet protocol described above. The first message **700** illustrates the broadcast of an emergency message "FF" from a central server with an address "0012345678" to a integrated transceiver with an address of "FF."

The second message **702** illustrates how the first message **700** may be sent to a stand-alone wireless communication device. In this manner, emergency message "FF" from a central server with address "00123456578" is first sent to stand-alone wireless device "FO." The second message **702**, further contains additional command data "A000123456" that may be used by the wireless communication device to identify further wireless communication devices to send the signal through on the way to the destination device.

The third message **704** illustrates how the open data packet protocol of the present invention may be used to "ping" a remote wireless communication device in order to determine the status of the wireless communication device. In this manner, source unit "E112345678" originates a ping request by sending command "08" to a transceiver identified as "A012345678." The response to the ping request may be as simple as reversing the "to address" and the "from address" of the command such that a healthy wireless communication device may send a ping message back to the originating device. Automated monitoring system **100** may be configured to expect a return ping within a specific time period. Operators of automated monitoring system **100** may use the delay between the ping request and the ping response to model system loads and to determine if specific system parameters might be adequately monitored and controlled with the expected feedback transmission delay.

Returning to FIG. **1**, the repeater **125** acts as a communications bridge between a remote device and the site controller **150** when the remote device cannot reliably communicate directly with the site controller **150**. In this manner, the repeater **125** may communicate in two or more modes: normal, emergency, etc.

For example, during normal communication, the repeater **125** may have two functions: repeating messages (including repeating upstream messages) and repeating downstream messages. Upstream messages are transmissions to another repeater **125** or remote device. Downstream messages are transmissions to another repeater **125** or site controller **150**. Responding to common messages involves taking the appropriate action and sending a response to the site controller **150**. The repeater **125** may modify the message depending upon the stream direction. An exemplary format for the data field **570** (FIG. **5**) for a downstream repeated message is set forth in FIG. **8**. For instance, the data field **570** may have a "Num Index" **810**, which may identify the number of indexes being sent with the downstream repeat. The indexes **820** may contain the downstream path including the intended recipient address. The "CMD" field **830** may identify the particular command for the intended receiving device. The "Data for last CMD" field **840** may include either an index table of downstream addresses or upstream addresses.

FIG. **9** sets forth an example of the structure for the data field **570** (FIG. **5**) of an upstream message. The "number of repeaters" **910** may indicate the number of upstream repeaters. The "Repeater Retry Counters" **920** may indicate the number of retries by each repeater in the upstream. The "CMD" field **930** may indicate the command sent to the intended remote device. The "Data for last CMD" **940** may indicate the data in response to the original command from the intended remote device.

Examples of commands that are sent directly from the site controller **150** to the repeater **125** include load upstream addresses. This command causes the repeater **125** to store the addresses to which the repeater **125** sends messages when communicating upstream. The loading of the upstream addresses also initiates a transceiver functioning as a repeater **125**. The response to a load command may be a status message that is sent to the site controller **150**.

Another example of a communication mode is emergency mode. In this mode, emergency messages are automatically transmitted upstream regardless of what other actions may be taking place. Unlike normal communications, emergency messages are sent unsolicited from the integrated transceiver **135** to the site controller **150**.

During all modes of communication, each of the communication devices may expect a response message to all messages sent. There may be at least two acknowledgements: a positive acknowledgement, a negative acknowledgement, etc. The positive acknowledgement may be sent whenever a message is received and understood. A negative acknowledgement may be sent whenever the message is not received and understood correctly or whenever an expected message is not received. A negative acknowledgment may be followed by a predetermined number of retries.

Further information regarding the structure and operation of the data packet protocol implemented in automated monitoring system **100** may be found in commonly assigned U.S. patent application "System and Method for Interconnecting Remote Devices in an Automated Monitoring System," Ser. No. 09/925,445 which is hereby incorporated in its entirety by reference.

Referring again to FIG. **1**, during normal operations, the site controller **150** acts as the communications master. Thus, the site controller **150** may initiate all communications with the wireless communications devices, except emergency messages described below. In addition to initiating command messages, the site controller **150** also tracks response messages. This tracking allows the site controller **150** to monitor the operational status of the wireless communication devices.

In addition to orchestrating communications with the wireless communication devices, the site controller **150** maintains current databases of information regarding the automated monitoring system **100**, such as, for example, the function of the wireless communication devices, the unique address for each of the wireless communication devices, and current data contained in response messages. One of ordinary skill in the art will appreciate that site controller **150** may contain information related to any of a variety of other aspects of automated monitoring system **100**.

As stated above, the site controller **150** also controls communications with the applications server **110**. When communicating with the applications server **110**, the site controller **150** receives requests for information, commands, etc. and sends the appropriate response. The applications server **110** maintains the requested information and/or commands in such a way that a user can access the information via a remote desktop **155**, remote laptop **160**, or any other device configured for communication with WAN **120**.

Furthermore, the site controller **150** may be configured to maintain a database of the wireless communication devices and their unique addresses. The unique addresses may be assigned such that the site controller **150** may easily send messages to one wireless communication device, a group of wireless communication devices, or all of the wireless communication devices.

Using the site controller **150** as a communications master and maintaining individual device information at the site controller **150** enables the wireless communication devices to be simplified. The simplification of the wireless communication devices has two main advantages: (1) simplifying the construction of the wireless communication device and (2) decreasing cost. The wireless communication device may be simplified because of a reduced need for large memory and/or storage devices. As well-known in the art, memory and storage devices increase in cost as they increase in size. Therefore, decreasing the size of the memory and/or storage reduces the construction and operating costs of the wireless communication devices.

The site controller **150** sends messages to the wireless communication devices using the open data packet protocol described above. Initially, the site controller **150** maps all of the wireless communication devices so as to "learn" all the unique addresses and the necessary communication paths. To do this mapping, the site controller **150** issues a command to document the down-stream addresses and the up-stream addresses for each communication path associated with a wireless communication device. The site controller **150** logs the response data from the wireless communication devices into the appropriate databases. Messages from the site controller **150** travel downstream to the intended wireless communication device(s). Messages from the wireless communication devices(s) travel upstream to the site controller **150**. When mapping the communication paths for each of the wireless communication devices, the site controller **150** "learns" the unique address of each wireless communication device, the addresses of each wireless communication device that can directly and reliably communicate with each transceiver/repeater(s) **125** in a downstream path, the unique address of each transceiver/repeater(s) **125** in a downstream path, the upstream addresses for the wireless communication device, and the downstream addresses for the wireless communication device.

When sending command messages, the site controller **150** expects an acknowledgement to each command. A command is considered to be not acknowledged when either the site controller **150** fails to receive a positive acknowledgement from the addressed wireless communication device within a first time period, fails to detect the re-transmission of the command message by a transceiver/repeater **125** within a second time period, or receives a negative acknowledgement from a transceiver/repeater **125** in the communication path of the wireless communication device. If the site controller **150** receives a negative acknowledgement, the site controller **150** can then log the failed message and retransmit the message. This re-transmission can occur a predetermined number of times. It should be noted the first time period may be longer than the second time period. In the above cases, the first time period is long enough to ensure receipt of the preamble of the response message when there are multiple transceiver/repeater(s) **125** in the communications path. The second time period is long enough to either receive the preamble of the response message (if no repeaters are in the communications path) or to hear the preamble of the command message being re-transmitted by the first transceiver/repeater **125** in the communication path of the wireless communication device.

After initializing and during normal operation, the site controller **150** may poll each of the remote sensor/actuators according to a predetermined schedule. During this process, the site controller **150** requests the current operating status of each of the sensors/actuators **135**. The status of a sensor/actuator device **135** depends upon the type of device. For example, a smoke detector's status may be operational/non-operational. In contrast, a utility meter's status may be the utility usage that has occurred since the last polling. A thermostat's status response may be the actual temperature and the desired temperature. The information sent in response to a status poll may vary depending upon the particular configuration of the sensor/actuator **135**. This information is maintained by the site controller **150** and may be sent to the applications server **110** upon request. The predetermined schedule has flexibility based upon the number of failed attempts and any emergency messages. To poll the device, the site controller **150** sends a "read status" message. The command message is considered complete upon receipt of the response message. The command message is considered failed upon receipt of a negative acknowledgement. After a negative acknowledgement, the site controller **150** retries the command six more times and logs all failed attempts.

To facilitate communications with the applications server **110**, the site controller **150** may maintain database files of information. The site controller **150** may maintain communication databases that store the device failures, as discussed above, and that store the emergency messages. These database stored logs can contain the unique address of the wireless communication device, a code representing a present condition, and a date/time stamp. Any failures to communicate with the applications server **110** are also logged into the appropriate database. These databases may have a predetermined size and may be forwarded to the applications server **110** when the databases are a specific percentage full or upon request by the applications server **110**. Once forwarded to and acknowledged by the applications server **110**, the entries in the communications databases are deleted. One of ordinary skill in the art will appreciate that the contents, size, and scheduling of database entries may be varied in a variety of ways.

After mapping the wireless communication devices, the site controller **150** develops and maintains a database that includes the unique address for each wireless communication device, the number of transceiver/repeaters **125** in the downstream path, the address of each transceiver/repeater **125** in the downstream path, the upstream addresses, and the downstream addresses. The site controller **150** does not necessarily respond to the messages from wireless communication devices not listed in this database.

In addition to mapping the wireless communication devices, the site controller **150** may update the device database via the applications server **110**. This update may add/delete wireless communication devices from the automated monitoring system **100**, change the communications path of any or all of the wireless communication devices, or change the unique addresses of any or all of the wireless communication devices. Upon request of the applications server **110**, the site controller **150** may transmit the device database to the applications server **110**.

It should be noted that the databases enumerated above are merely exemplary, and other databases may be included as would be obvious to one of ordinary skill in the art.

The "normal" operating procedure described above is continued unless the site controller **150** receives an emergency message from a wireless communication device. The emergency message is transmitted unsolicited. The emergency message can be received by the site controller **150** either directly, via a repeater, or via a plurality of repeaters. Upon receipt of an emergency message, the site controller **150** immediately notifies the applications server **110** of the emergency message. In addition, the site controller **150** suspends the above polling for a predetermined time period. This suspension insures the receipt of any additional emergency messages. After the time period expires with no additional messages, the site controller **150** resumes polling.

To facilitate communications between the applications server **110** and the site controller **150**, the site controller **110** maintains a database of contact information. By way of example, if the site controller **150** communicates via a network interface device **408**, the site controller **150** can maintain a database of telephone numbers and IP addresses of the applications server **110**.

During normal communications, the applications server **110** sends response messages. As stated above, one of ordinary skill in the art will appreciate that the applications server **110** and the site controller **150** may communicate via TCP/IP protocol or any other protocol. Exemplary requests include a "get file" request of the database and a "put file" request, which sends a file to the site controller **150**.

Normal communications between the site controller **150** and the applications server **110** may also be interrupted by an emergency message. The emergency message originates at the site controller **150** and may include an emergency message from a remote device, a "file too large" message, and a site controller status change message to name a few. In the case of safety and security system devices such as smoke detectors, glass break alarms, etc., the site controller **150** may immediately generate an emergency message to the applications server **110** in the event a safety/security device fails to respond to a poll message.

FIG. **10** sets forth an alternate embodiment of an automated monitoring system **100**. Automated monitoring system **100** of FIG. **1** is shown with an additional sensor **180** and transceiver **185**. The additional sensor **180** and transceiver **185** are shown to be communicating with, but outside of, the coverage area **165**. In this example, the additional sensor **180** and transceiver **185** may be placed outside of the original control system. In order to communicate, the coverage area of transceiver **185** need only overlap the coverage area **165**. By way of example only, the original installation may be an automated monitoring system **100** that monitors electricity usage via the utility meters in an apartment complex. Later a neighbor in a single family residence nearby the apartment complex may remotely monitor and control their thermostat by installing a sensor/actuator transceiver according to the present invention. The transceiver **185** then communicates with the site controller **150** of the apartment complex. If necessary, repeaters (not shown) can also be installed to communicate between the transceiver **185** and the apartment complex site controller **150**. Without having the cost of the site controller **150**, the neighbor may enjoy the benefits of the control system.

FIG. **11** illustrates an automated monitoring network **1100** according to the present invention for enabling multiple groups of remote devices associated with multiple wireless communication networks to be monitored and/or controlled via a common connection to a wide area network, such as a WAN **120**. As illustrated in FIG. **11**, automated monitoring network **1100** comprises a primary automated monitoring system, such as automated monitoring system **100**, and a secondary wireless communication network **1110** in communication with automated monitoring system **100**. Automated monitoring system **100** may operate and be configured as described above.

For example, automated monitoring system **100** may comprise a plurality of remote devices to be monitored and/or controlled, a plurality of communication devices, such as transceivers **125** and **135**, a site controller **150**, a WAN **120**, and a host computer, such as an applications server **110**, a laptop **155**, or a workstation **160**. Each of the plurality of remote devices may be in communication with one of the plurality of communication devices such that a primary wireless communication network is defined within coverage area **165**. In this manner, the primary wireless communication network associated with automated monitoring system **100** provides communication between each of the remote devices within coverage area **165** and the site controller **150**. Hereinafter, the remote devices associated with automated monitoring system **100** will be referred to as the first group of remote devices.

Secondary wireless communication network **1110** may comprise a second group of remote devices to be monitored and/or controlled and a plurality of communication devices, such as transceivers **125** and **135**. Each of the second group of remote devices in secondary wireless communication network **1110** may be in communication with one of the plurality of communication devices such that the secondary wireless communication network **1110** is defined within coverage area **1120**. Secondary wireless communication network **1110** may operate and be configured in a manner similar to the primary wireless communication network of automated monitoring system **100**. For example, secondary wireless communication network **1110** may employ transceivers **125** and **135** as described above. Secondary wireless communication network **1110** may also employ the communication protocol described above. Nonetheless, one of ordinary skill in the art will appreciate that other transceivers and other communication protocols may be employed.

As illustrated in FIG. **11**, automated monitoring system **100** includes one or more site controllers **150** that manage communications with applications server **110** via WAN **120**. Significantly, automated monitoring network **1100** according to the present invention enables the secondary wireless communication network **1110** to access WAN **120** via the primary wireless communications network. Thus, the secondary wireless communication network **1110** does not have to use a separate site controller **150** in order to communicate with applications servers **110**, laptop **155**, workstation **160**, or other computing devices connected to WAN **120**. Instead, the secondary wireless communication network **1110** may access the site controller **150** in automated monitoring system **100** via the primary wireless communication network. For example, at least one of the communication devices in the secondary wireless communication network **1110** may communicate with at least one of the communication devices in automated monitoring system **100**. In this manner, messages may be exchanged between the site controller **150** of the primary wireless communication network and the second group of remote devices, thereby enabling the second group of remote devices to be monitored and/or controlled via the site controller **150** and/or the various computing devices connected to WAN **120**.

The transceivers in automated monitoring system **100** and secondary wireless communication network **1110** may be configured to receive data signals from other devices and/or appliances via other wireless technologies, such as Bluetooth and the 802.11 (b) standard adopted by the Institute of Electrical and Electronics Engineers (IEEE), which is hereby incorporated by reference in its entirety. For instance, the transceivers may be configured to implement the technology described in "Specification of the Bluetooth System: Specification Volume 1," Feb. 22, 2001, which is hereby incorporated by reference in its entirety. In addition, infrared, ultrasonic, and other types of wireless transceivers may be employed as one of ordinary skill in the art will appreciate.

One of ordinary skill in the art will appreciate that automated monitoring network **1100** provides a number of advantages for monitoring and/or controlling remote devices. For example, automated monitoring network **1100** reduces the expense associated with monitoring and/or controlling the second group of remote devices in the secondary wireless communication network **1110**. Specifically, the automated monitoring network **1100** according to the present invention eliminates the need for a separate site controller **150** and separate access to WAN **120**. Furthermore, automated monitoring network **1100** promotes cooperative relationships between organizations providing remote monitoring.

By way of example, automated monitoring system **100** may be used by an organization to enable customers to monitor and/or control a first group of remote devices. For instance, automated monitoring system **100** may be used to provide individual residences in a managed apartment complex with the ability to remotely monitor and/or control a residential application, such as a residential security system. As described above and illustrated in FIG. **1**, in this example automated monitoring system **100** may enable residents of the apartment complex to monitor and/or control the status of their residential security system via a laptop **155**, workstation **160**, or other computing device in communication with WAN **120**.

Automated monitoring network **1100** enables a second group of remote devices associated with secondary wireless communication network **1110** to be monitored and/or controlled without obtaining a separate site controller **150** and separate access to WAN **120**. As stated above, the secondary wireless communication network **1110** may access WAN **120** via the primary automated monitoring system **100**. For example, in the above example, the second group of remote devices associated with secondary wireless communication network **1110** may be the electric meters for each of the residences in the managed apartment complex. The electric utility company that provides service to the managed apartment complex may desire to provide remote monitoring to the residents. Automated monitoring network **1100** according to the present invention enables the electric utility company to easily provide remote monitoring of the electric meters to the residents.

For instance, the electric utility company does not have to establish an independent automated monitoring system **100**. Rather, the electric utility company only needs to establish a secondary wireless communication network **1110** as described above. Each of the electric meters may be communicatively coupled to a wireless transceiver, such as a transceiver **125** and transceiver **135** described above. In order to ensure communication throughout the entire coverage area **1120** of the electric meters associated with the secondary wireless communication network **1110**, it may be necessary to implement additional wireless transceivers and/or repeaters as described above. In this manner, the collection of wireless transceivers associated with the electric meters defines the secondary wireless communication network **1110**. As mentioned above, secondary wireless communication network **1110** may operate and be configured in a manner similar to the primary wireless communication network of automated monitoring system **100**.

Given the existence of the secondary wireless communication network **1110**, the electric utility company may provide remote monitoring of the electric meters to the residents via the automated monitoring system **100** for monitoring and/or controlling the residential security systems. The only requirement is that at least one of the wireless transceivers associated with the electric meters is in communication with at least one of the wireless transceivers associated with the residential security systems. Data messages related to the secondary wireless communication system **1110** may be passed through the primary wireless communication network to the site controller **150** and on to applications server **110** via WAN **120**, thereby enabling the electric meters to be monitored and/or controlled via the site controller **150** and/or the various computing devices connected to WAN **120**.

One of ordinary skill in the art will appreciate that the secondary wireless communication network **1110** and the automated monitoring system **100** may employ any of a variety of types of remote devices. Accordingly, the specific needs of the secondary wireless communication network **1110** and the automated monitoring system **100** may differ. For example, secondary wireless communication network **1110** and the automated monitoring system **100** may differ only in the type of devices being monitored and/or controlled. As in the above example of one of many possible embodiments, coverage area **165** of automated monitoring system **100** and coverage area **1120** of secondary wireless communication network **1110** may be substantially overlapping. However, in other embodiments of automated monitoring network **1100**, coverage area **165** and coverage area **1120** only have to overlap such that at least one transceiver from both secondary wireless communication network **1110** and automated monitoring system **100** communicate.

One of ordinary skill in the art will appreciate that what has been described herein is a very top-level illustration of a system constructed in accordance with the automated monitoring system **100** and the automated monitoring network **1100** of the present invention. In accordance with the invention, a variety of remote devices, such as utility meter devices, personal security devices, household devices and appliances, and other remote devices employing a sensor and/or an actuator, may be monitored and/or controlled from a remote location via a computing device connected to WAN **120**. The data and command transmissions may be transmitted and received by the site controller **150** connected to WAN **120**. Site controller **150** is further in communication with the wireless communication devices within coverage area **165**. The data and command transmissions may be relayed via the various wireless communication devices defining the communication path until they reach a designated destination or the site controller **150**.

It will be further appreciated that automated monitoring system **100** in accordance with the present invention may be used in a variety of environments. In one embodiment, automated monitoring system **100** may be employed to monitor and record utility usage by residential and industrial customers, to transfer vehicle diagnostics from an automobile via a wireless transceiver integrated with the vehicle diagnostics bus to a local transceiver that further transmits the vehicle information through a local gateway onto a WAN, to monitor and control an irrigation system, to automate a parking facility, to monitor and control a residential security system, etc, which are described in more detail in the commonly assigned U.S. patent application entitled, "System and Method for Monitoring and Controlling Residential Devices," issued Ser. No. 09/704,150.

Automated monitoring system **100** may be adapted to monitor and apply control signals in an unlimited number of applications. By way of example only, the wireless communication devices may be adapted for use with any associated device, such as, for example, pay type publicly located telephones, cable television set top boxes, utility meters, and residential appliances and/or devices to enable a remote controllable home automation and security system.

In a geographic area appropriately networked with permanently located stand-alone transceivers **125**, personal transceivers (not shown) may be used to monitor and control personnel access and egress from specific rooms or portions thereof within a controlled facility. Personal transceivers may further be configured to transfer personal information to public emergency response personnel, to transfer personal billing information to vending machines, or to monitor individuals within an assisted living community.

Wireless communication devices using the open data packet protocol of the present invention may be integrated to monitor and control a host of industrial and business applications as well. By way of example only, building automation systems, fire control systems, alarm systems, industrial trash compactors, and building elevators may be monitored and controlled. In addition, courier drop boxes, time clock systems, automated teller machines, self-service copy machines, and other self-service devices may be monitored and controlled as appropriate. By way of further example, a number of environment variables that require monitoring may be integrated with automated monitoring system **100** to permit remote monitoring and control. For instance, light levels in the area adjacent to automated teller machines must meet minimum federal standards. Also, the water volume transferred by water treatment plant pumps, smokestack emissions from a coal burning power plant, or a coke fueled steel plant oven may be remotely monitored.

The wireless communication devices using the open data packet protocol of the present invention may be further integrated with a voice-band transceiver having multiple function buttons. As a result, when a person presses, for example, the emergency button on his/her transmitter, medical personnel, staff members, or others may respond by communicating via two-way radio with the party in distress. In this regard, each transceiver may be equipped with a microphone and a speaker that would allow a person to communicate information such as their present emergency situation, their specific location, etc.

The foregoing description has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obvious modifications or variations are possible in light of the above teachings. For example, it should be appreciated that, in some implementations, the transceiver unique address is not necessary to identify the location of the transceiver. Indeed, in implementations where the transceiver is permanently integrated into an alarm sensor other stationary device within a system, then the applications server **110** and/or the site controller **150** may be configured to identify the transmitter location by the transmitter unique address alone. It will be appreciated that, in embodiments that do not utilize wireless transceiver/repeaters **125**, the wireless transmitters **145** and/or wireless transceivers **135** may be configured to transmit at a higher power level, in order to effectively communicate with the site controller **150**.

The embodiment or embodiments discussed were chosen and described to illustrate the principles of the invention and its practical application to enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly and legally entitled.

The invention claimed is:

1. A wireless communication network adapted for use in an automated monitoring system for monitoring and controlling a plurality of remote devices via a host computer connected to a wide area network, the wireless communication network comprising:

a plurality of wireless transceivers having unique identifiers, each of the plurality of wireless transceivers configured to receive a sensor data signal from one of the plurality of remote devices and transmit an original data message using a predefined wireless communication protocol, the original data message comprising the corresponding unique identifier and sensor data signal, and further configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal and the corresponding unique identifier; and

a site controller in communication with at least one of the plurality of wireless transceivers, the site controller configured to receive the original data messages and the repeated data messages, identify the remote device associated with the corresponding sensor data signal, and provide information related to the sensor data signal to the wide area network for delivery to the host computer.

2. The wireless communication network of claim **1**, further comprising a plurality of repeaters having unique identifiers, each of the plurality of repeaters in communication with at least one of the plurality of wireless transceivers and configured to receive the original data message transmitted by the at least one of the plurality of wireless transceivers and transmit a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal from the original data message and the unique identifier corresponding to the repeater.

3. The wireless communication network of claim **1**, wherein the site controller is further configured to provide a command message to one of the plurality of wireless transceivers and each of the plurality of wireless transceivers are further configured to transmit, in response to the command message, the original data message, wherein the original data message corresponds to the command message.

4. The wireless communication network of claim **1**, wherein the predefined communication protocol comprises a data packet comprising:

a receiver address identifying the receiver of the data packet;

a sender address identifying the sender of the data packet; and

a command indicator specifying a predefined command code.

5. The wireless communication network of claim **4**, wherein the data packet further comprises:

a packet length indicator which indicates a total number of bytes in the current packet;

a total packet indicator which indicates the total number of packets in the current message;

a current packet indicator which identifies the current packet; and

a message number identifying the current message.

6. The wireless communication network of claim **1**, wherein the plurality of wireless transceivers are further configured to receive signals via Bluetooth technology.

7. The wireless communication network of claim **1**, wherein the plurality of wireless transceivers are further configured to receive signals via IEEE standard 802.11(b).

8. A wireless communication network adapted for use in an automated monitoring system for monitoring and controlling a plurality of remote devices via a host computer connected to a wide area network, the wireless communication network comprising:

a plurality of wireless communication means having unique identifiers, each of the plurality of wireless communication means configured to receive a sensor data signal from one of the plurality of remote devices and transmit an original data message using a predefined wireless communication protocol, the original data message comprising the corresponding unique identifier and sensor data signal, and further configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal and the corresponding unique identifier;

a means for receiving each of the original data messages and the repeated data messages;

a means for identifying, for each received message, the remote device associated with the corresponding sensor data signal; and

a means for providing information related to the sensor data signal to the wide area network for delivery to the host computer.

9. The wireless communication network of claim **8**, further comprising a plurality of repeating means having unique identifiers, each of the plurality of repeating means in communication with at least one of the plurality of wireless communication means and comprising a means for receiving the original data message transmitted by the at least one of the plurality of wireless transceivers and a means for transmitting a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal from the original data message and the unique identifier corresponding to the repeater.

10. The wireless communication network of claim **8**, further comprising a means for providing a command message to one of the plurality of wireless communication means, wherein each of the wireless communication means further comprise a means for transmitting, in response to the command message, the original data message, wherein the original data message corresponds to the command message.

11. The wireless communication network of claim 8, wherein the predefined communication protocol comprises a data packet comprising:

a means for identifying the receiver of the data packet;

a means for identifying the sender of the data packet; and

a command means for specifying a predefined command code.

12. The wireless communication network of claim 11, wherein the data packet further comprises:

a means for indicating a total number of bytes in the current packet;

a means for indicating the total number of packets in the current message;

a means for identifying the current packet; and

a means for identifying the current message.

13. A wireless communication network for monitoring and controlling a plurality of remote devices via a host computer connected to a wide area network, the wireless communication network comprising:

a plurality of wireless transceivers having unique identifiers, each of the plurality of wireless transceivers configured to receive a sensor data signal from one of the plurality of remote devices and transmit an original data message using a predefined wireless communication protocol, the original data message comprising the corresponding unique identifier and sensor data signal, and further configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal and the corresponding unique identifier;

wherein at least one of the plurality of wireless transceivers is further configured to provide the original data messages and the repeated data messages to a site controller connected to the wide area network.

14. The wireless communication network of claim 13, further comprising a plurality of repeaters having unique identifiers, each of the plurality of repeaters in communication with at least one of the plurality of wireless transceivers and configured to receive the original data message transmitted by the at least one of the plurality of wireless transceivers and transmit a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal from the original data message and the unique identifier corresponding to the repeater.

15. The wireless communication network of claim 13, wherein the at least one of the plurality of wireless transceivers is further configured to receive a command message for one of the plurality of wireless transceivers from the site controller and transmit the command message to the one of the plurality of wireless transceivers.

16. The wireless communication network of claim 13, wherein the predefined communication protocol comprises a data packet comprising:

a receiver address identifying the receiver of the data packet;

a sender address identifying the sender of the data packet; and

a command indicator specifying a predefined command code.

17. The wireless communication network of claim 16, wherein the data packet further comprises:

a packet length indicator which indicates a total number of bytes in the current packet;

a total packet indicator which indicates the total number of packets in the current message; and

a current packet indicator which identifies the current packet; and

a message number identifying the current message.

18. The wireless communication network of claim 13, wherein the plurality of wireless transceivers are further configured to receive signals via Bluetooth technology.

19. The wireless communication network of claim 13, wherein the plurality of wireless transceivers are further configured to receive signals via IEEE standard 802.11(b).

20. A wireless communication network for monitoring and controlling a plurality of remote devices via a host computer connected to a wide area network, the wireless communication network comprising:

a plurality of wireless transceivers having unique identifiers, each of the plurality of wireless transceivers configured to receive a sensor data signal from one of the plurality of remote devices and transmit an original data message using a predefined wireless communication protocol, the original data message comprising the corresponding unique identifier and sensor data signal, and further configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal and the corresponding unique identifier;

wherein at least one of the plurality of wireless transceivers is further configured to provide the original data messages and the repeated data messages to a primary wireless communication network associated with an automated monitoring system.

21. The wireless communication network of claim 20, further comprising a plurality of repeaters having unique identifiers, each of the plurality of repeaters in communication with at least one of the plurality of wireless transceivers and configured to receive the original data message transmitted by the at least one of the plurality of wireless transceivers and transmit a repeated data message using the predefined communication protocol, the repeated data message including the sensor data signal from the original data message and the unique identifier corresponding to the repeater.

22. The wireless communication network of claim 20, wherein the at least one of the plurality of wireless transceivers is further configured to receive a command message for one of the plurality of wireless transceivers from the primary wireless communication network and transmit the command message to the one of the plurality of wireless transceivers.

23. The wireless communication network of claim 20, wherein the predefined communication protocol comprises a data packet comprising:

a receiver address identifying the receiver of the data packet;

a sender address identifying the sender of the data packet; and

a command indicator specifying a predefined command code.

24. The wireless communication network of claim 23, wherein the data packet further comprises:

a packet length indicator which indicates a total number of bytes in the current packet;

a total packet indicator which indicates the total number of packets in the current message;

a current packet indicator which identifies the current packet; and

a message number identifying the current message.

25. The wireless communication network of claim **20**, wherein the plurality of wireless transceivers are further configured to receive signals via Bluetooth technology.

26. The wireless communication network of claim **20**, wherein the plurality of wireless transceivers are further configured to receive signals via IEEE standard 802.11(b).

27. A method for enabling customers to monitor remote devices via a wide area network (WAN), the method comprising the steps of:

establishing a wireless communication network that enables each of a plurality of customers to monitor at least one remote device via a wide area network, the wireless communication network comprising:

a plurality of wireless transceivers each integrated with one of the plurality of remote devices and having a unique identifier and configured to receive a sensor data signal from the remote device and transmit an original data message using a predefined wireless communication protocol, the original data message comprising the corresponding unique identifier for the originating wireless transceiver, each wireless transceiver further configured to receive the original data message transmitted by one of the other wireless transceivers and transmit a repeated data messaging using the predefined communication protocol, the repeated data message including the original sensor data signal and the corresponding unique identifiers for the originating wireless transceiver and the repeating wireless transceiver; and

a site controller in communication with at least one of the plurality of wireless transceivers, the site controller configured to receive the original data messages and the repeated data messages, identify the remote device associated with the corresponding sensor data signal, and provide information related to the sensor data signal to a WAN for delivery to a host computer; and

providing an organization access to the wireless communication network.

28. The method of claim **27**, further comprising the step of receiving compensation for providing the organization access to the wireless communication network.

29. The method of claim **28**, wherein the step of providing the organization access to the wireless communication network comprises enabling at least one remote device corresponding to a customer of the organization to communicate with the wireless communication network so that the remote device may be monitored via the WAN.

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