

## SUMMARY OF THE INVENTION

[007] Embodiments of the present invention are directed to network architectures for providing networked communications between a series of medical devices and remote monitoring devices. In accordance with a preferred embodiment of the invention, one or more medical devices including, for example, enteral feeding, thermometers, pulse oximeters, respirators, blood pressure monitors, pulse monitors, weight scales and glucose meters) are provided at a patient facility. An interface circuit is coupled to each medical device, and is configured for communicating with one of a plurality of wireless relay modules via a wireless relay network. The wireless relay modules are further configured to communicate with a remote monitoring device over an internet-accessible wireless communication network, and preferably, a wireless wide-area network (WWAN) such as a mobile telephone data network, e.g. 3G or 4G network. Also, for compliance for example with HIPAA regulations, communications over each of the wireless networks are preferably conducted securely.

[007a] According to the first aspect of the invention, a system for providing communications between one or more medical devices and a remote device connected to the Internet is provided. The system comprises: at least one interface circuit coupled to one or more of the one or more medical devices and capable of transmitting medical device data using a wireless data connection; at least two relay modules, each of the at least two relay modules wirelessly coupled to form a mesh network of wireless relay modules, with each of the at least two relay modules comprising: a first receiver capable of wirelessly receiving medical device data over the wireless data connection; a first transmitter capable of wirelessly transmitting medical device data to another of the at least two relay modules over the mesh network of wireless-relay modules; a second transmitter capable of wirelessly transmitting medical device data over an Internet-accessible wireless communications network; and a processor coupled to the second transmitter to determine if the Internet-accessible wireless communications network is accessible by the second transmitter and coupled to the first transmitter to transmit the medical device data over the mesh network of wireless-relay modules to another of the at least two relay modules if the Internet-accessible wireless communications network is not accessible by the second transmitter; wherein at least one of the at least two relay modules in the mesh network of

wireless relay modules is capable of determining an access status of the mesh network of wireless relay modules and providing the access status to the processor for selecting the first or second transmitter for medical device data transmission based on at least two of: (1) the access status of the mesh network of wireless relay modules; (2) a device status of the one or more medical devices; and (3) a connection status of each of the first and second transmitters in the wireless relay modules; wherein the connection status of the first transmitter indicates whether the Internet-accessible wireless communications network is accessible to the wireless relay modules and the connection status of the second transmitter indicates whether the mesh network of wireless relay modules is accessible to the wireless relay modules; and wherein each of the relay modules in the wireless mesh network is configured to determine its own current status and to communicate its own current status to each of the other relay modules in the wireless mesh network.

[007b] According to the second aspect of the invention, a process for communicating medical device data from one or more medical devices over a wireless network is provided. The process comprises the steps of: forming a wireless mesh network from a plurality of relay modules; receiving at a first relay module via the wireless mesh network medical device data transmitted by at least one interface circuit coupled to a respective medical device; determining a first relay module status of access by said first relay module to an Internet-accessible wireless communications network; transmitting said medical device data by said first relay module over said Internet-accessible wireless communications network when said Internet-accessible wireless communications network is accessible; and transmitting said medical device data by said first relay module to a second relay module over the wireless mesh network when said Internet-accessible wireless communications network is not accessible; wherein at least one relay module in the wireless mesh network is capable of determining an access status of the mesh network of wireless relay modules and providing the access status to a processor of the first relay module for selecting a first and second transmitter for medical data transmission based upon at least two of: (1) the access status of the mesh network of wireless relay modules; (2) a device status of the one or more medical devices; and (3) a connection status of each of the first and second transmitters in the wireless relay modules; wherein the connection status of the first transmitter indicates whether the Internet accessible wireless communications network is accessible to the first

wireless relay module and the connection status of the second transmitter indicates whether the wireless mesh network is accessible to the first wireless relay module; and wherein each of the relay modules in the wireless mesh network is configured to determine its own current status and to communicate its own current status to each of the other relay modules in the wireless mesh network.

[007c] According to the third aspect of the invention, a system is provided comprising: at least one medical device, each of said at least one medical device having at least one interface circuit coupled thereto, with each of said at least one interface circuits configured to receive medical device data from at least one of said at least one medical devices and configured to transmit medical device data provided thereto using a wireless data connection; and at least two relay modules, each of the at least two relay modules wirelessly coupled to each of said at least one medical devices via respective interface circuitry such that each of said at least two relay modules and at least some of said at least one medical devices form a wireless mesh relay network over which each of said at least two relay modules are capable of wirelessly receiving medical device data transmitted by one or more of said interface circuitry and wherein at least one relay module is capable of determining an access status of the wireless mesh relay network and selecting a wireless communication path for medical device data transmission and wherein at least one of the at least two relay modules is capable of transmitting medical device data provided thereto over an Internet-accessible wireless communications network and wherein each of the at least two relay modules selects the wireless communication path based upon at least two of: (1) the access status of the wireless mesh relay network; (2) a device status for each of the at least one medical device; and (3) a connection status of the at least one relay module to the Internet accessible wireless communications network; wherein the connection status comprises: a first connection status which indicates whether the Internet accessible wireless communications network is accessible by the wireless relay modules; and a second connection status indicates whether the wireless mesh relay network is accessible by the wireless relay module; and wherein each of the relay modules in the wireless mesh relay network is configured to determine its own current status and to communicate its own current status to each of the other relay modules in the wireless mesh relay network.

[008] Each of the plurality of wireless relay modules includes a receiver capable of wirelessly receiving medical device data from respective interface circuits via the wireless relay network, a first transmitter capable of wirelessly transmitting medical device data to another one of the wireless relay modules over the wireless relay network, a second transmitter capable of wirelessly transmitting data over an internet-accessible wireless communications network; and a controller coupled to the first and second transmitters. The controller is configured to determine access status of the internet-accessible wireless communications network, and to select one of the first or second transmitters based on that status. For example, when the status indicates that the internet-accessible wireless communications network is accessible to the wireless relay module, the controller selects the second transmitter for transmitting medical device data transmitted by the interface circuit to the internet-accessible wireless communications network. When the status indicates that the internet-accessible wireless communications network not accessible, the controller selects the first transmitter for transmitting the medical device data to another one of the wireless relay modules. In this manner, additional attempts to transmit the medical device data over the internet-accessible wireless communication network can be attempted by this other wireless relay module (and potentially additional ones of the wireless relay modules) until a successful transmission is achieved.