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(54) **OPTIMIZING PHYSIOLOGIC MONITORING BASED ON AVAILABLE BUT VARIABLE SIGNAL QUALITY**

OPTIMIERUNG PHYSIKALISCHER ÜBERWACHUNGEN AUF BASIS VERFÜGBARER, ABER VARIABLER SIGNALQUALITÄTEN

OPTIMISATION DE SURVEILLANCE PHYSIOLOGIQUE BASÉE SUR UNE QUALITÉ DE SIGNAL DISPONIBLE MAIS VARIABLE

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Description

[0001] The present innovation finds particular application in patient monitoring, particularly involving physiologic monitoring over a healthcare network. However, it will be appreciated that the described technique may also find application in other information transmission and communication scenarios or techniques.

[0002] Utilization of contention-based wired and wireless networks provides a communication layer for a safe level of physiologic monitoring. Use of private networks and protected radio spectra support this effort. In many cases, wired bandwidth and wireless spectra (collectively referred as signal quality) are not available where applications need to run on existing and shared (e.g., not private) infrastructure. One drawback of conventional systems is that it is difficult to ensure that critical information is passed to the system when interference or contentious congestion limits the amount of available network bandwidth. In some applications the network is adaptive to support certain applications as higher traffic priorities over other applications where data latency and drop-out are not tolerated (Voice over IP as an example).

[0003] Often, the local area networks are employed in hospital networks, and the load on such networks varies significantly. When the load is high, or interferences exist, the available signal quality to any of the devices is low and the user perceived signal quality becomes poor. When the devices tries to upload more data than the network can carry, packets go undelivered, get lost, and the like. This creates gaps in the monitored data and can result in missing physiologic information necessary to feed alerting algorithms or reconstruct data in review applications. When a device fails to receive the required confirmations (e.g., an acknowledgement or "ACK") and when some number of packets has been unsuccessfully received or delayed, the devices consider the connection lost and may try to reestablish a new connection. This causes breaks and gaps in the data and in the monitoring. This is particularly troubling when physiologic waveforms data becomes gap data.

[0004] Conventional physiologic monitoring systems expect a fixed bandwidth over which to pass required application data. When interferers are present that reduce the available signal quality, essential performance is typically not met and the user is alerted to the loss of monitoring. Again, such systems typically shut down the connection completely and then re-establish a connection once adequate connection quality is present.

[0005] US 2005/002379 describes background information relating to dynamic real-time quality management of packetized communications in a network environment. The international Application WO 00/11841 discloses a method for data transmission where nodes reduce the amount of data to be sent whilst maintaining the transmission of more important high priority data.

[0006] The present application provides new and improved physiologic monitoring systems and methods, which overcome the above -referenced problems and others.

[0007] In accordance with one aspect, a network communication optimization system includes a transceiver that transmits and receives data over a network, and a signal quality analyzer that detects network congestion and latency as a function of actual data delivery and application-based latency measurement. The system further includes a transmission controller that selectively reduces current data types to be transmitted by the transceiver during periods of diminished signal quality according to a predetermined data type hierarchy, and a buffer that stores gap data omitted during reduced data transmission. In accordance with another aspect, a method of optimizing data transmission in response to network congestion includes continuously monitoring signal quality availability on a network, and transmitting all current data when signal quality availability is above a first predetermined threshold. The method further includes incrementally reducing current data transmission according to a predetermined data type hierarchy to be successively omitted when signal quality availability drops below each of N successive predetermined thresholds, wherein N is a positive number and includes the first predetermined threshold, and buffering omitted data (or other data acquired when there is no network connectivity), for later transmission. Additionally, the method includes incrementally increasing current data transmission according to the predetermined data type hierarchy of when signal quality availability rises above any of the N successive predetermined thresholds, including the first predetermined threshold, and transmitting the omitted data when signal quality availability returns to a level above the first predetermined threshold.

[0008] One advantage is that communication links are not completely terminated during reduced bandwidth periods.

[0009] Another advantage resides in ensuring higher priority data, such as patient monitoring alarms are transmitted, even during periods of severely diminished bandwidth.

[0010] Another advantage is that the application adapts to the ability to get the data to the target client and keeps track of what is missing so all the data will eventually get to the system repository.

[0011] Another advantage is that there are no special network considerations or prior commitment to dedicated bandwidth needed to support the adaptive data algorithm.

[0012] Still further advantages of the subject innovation will be appreciated by those of ordinary skill in the art upon reading and understanding the following detailed description.

[0013] The present invention is defined by the independent claims, to which reference should now be made. Specific embodiments are defined by the dependent claims. The innovation may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating various aspects and are not to be construed as limiting the invention.

FIGURE 1 illustrates a data transmission optimization system for utilizing an adaptable data communication process whereby applications throttle data between devices and the system in cases where network congestion or latency is present.

FIGURE 2 is an illustration of a graph showing examples of data type hierarchical relationships as a function of signal quality availability.

FIGURE 3 illustrates a flow chart diagram of a method of selectively adjusting data transmission as a function of signal quality availability, in accordance with various aspects described herein.

[0014] Systems and methods are described herein that detect available signal quality variations, automatically throttle application access and communication content, and provide a mechanism for the exchange of data once the expected network signal quality resumes. These systems and methods have specific relevance to medical device and health information systems for wired and wireless medical LAN applications, and have broader application to other areas where critical data throughput is impaired by variable signal quality (wired and wireless bandwidth) infrastructure.

[0015] FIGURE 1 illustrates a data transmission optimization system **10** for utilizing an adaptable data acquisition process whereby applications throttle data and data types between devices and the system in cases where network congestion is present. This unique approach ensures that expected performance levels are maintained and further provide a method where gap data (data unknown to the network) is cached by the device and transmitted at a later time when sufficient bandwidth is present.

[0016] The system **10** includes a transceiver **12** that transmits data to and receives data from a hospital network, such as a hospital network comprising a plurality of patient monitors, workstations, servers including a central server **13,** non-medical devices, applications, and the like. The transceiver is coupled to a multiplexer/demultiplexer (MUX/DEMUX) **14** that multiplexes and/or modulates outgoing data and demultiplexes and/or demodulates incoming data for processing by a processor **16.** The processor is coupled to a memory **18** that stores incoming data (e.g., pre- and post-processed data), data to be transmitted to the network, algorithms and/or routines for processing data, evaluating signal quality, adjusting data transmission volume as a function of available signal quality, and the like.

[0017] The processor includes a signal quality analyzer **20** that detects and quantifies network congestion. The signal quality analyzer includes an ACK/NACK analyzer **22** that quantifies a ratio of transmitted data packets for which acknowledgements have been received (e.g., indicating successful receipt by the network server **13** and/or other recipient devices) versus transmitted packets for which no acknowledgement has been received. This ratio is employed by the signal quality analyzer to infer that network congestion is present and that available signal quality is therefore diminished. The signal quality analyzer also includes an application-based latency analyzer **27** so data that arrives, but arrives late can be detected by a receiving application and included in the determination of adequate system throughput. In one embodiment, the latency analyzer analyzes a data reading number for a given data type, wherein the data reading number is a data packet encoded with a high resolution clock counter via which the latency analyzer measures latency. In another embodiment, the data itself is used to determine throughput and latency, permitting data measurement to be made in transmission modes such as transmission control protocol (TCP), user datagram protocol (UDP) or any other suitable transmission mode. Yet another approach relates to reserving bandwidth for pre-specified applications, which facilitates employing the systems and methods described herein on any communication network without reliance on quality of service.

[0018] The signal quality analyzer **20** can optionally perform period or continuous review of historical signal quality data for comparison to the current signal quality data in view of the predetermined signal quality thresholds delineated in the data type hierarchy. This historical quality data can additionally be used as a trigger to notify clinical users to the reason of limited data availability in the medical application, as well as the system administrator to potential problems in the network. A transmission controller **24** then executes a routine (e.g., stored in the memory) for omitting predefined data types form a transmission signal to reduce data transmission volume during the period of diminished signal quality or increased latency. The order in which data types are omitted as signal quality decreases is a function of a predefined data type hierarchy **26** stored in the memory **18.**

[0019] The processor **16** is additionally coupled to a plurality of physiologic sensors and physiologic waveforms such as generic waveforms (e.g., electrocardiogram and the like), an alert generator **21,** and/or one or more other types of physiologic, device, and/or patient data **25** that describe patient parameters (e.g., heart rate, blood pressure, respiration rate, SpO_2, or any other parameter that can be monitored or used in conjunction with monitoring for clinical decisions and alerting including patient demographics and reports). These devices provide the data to be output from the processor **16** to the hospital network.

[0020] Data to be transmitted is passed from the processor through an output buffer **28** to the MUX for modulation and/or multiplexing before being transmitted to the network by the transceiver. During periods of reduced data transmission (e.g., due to diminished signal quality as detected by the signal quality analyzer), the transmission controller omits one or more data types as prescribed by the data type hierarchy. Omitted data is cached to a gap data buffer **30** that stores the gap data until sufficient signal quality is available for transmission.

[0021] In one embodiment, the signal quality analyzer continuously monitors signal quality availability and delivery latency, and when the ACK/NACK analyzer does not detect any NACKs (e.g., for a prescribed time period or number of data packets), or appreciable delivery delay (latency) the transmission controller adds omitted data types back to a current transmission as prescribed by the hierarchy (e.g., in reverse order relative to the order of omission). Once signal quality availability has increased to a level at which all data types are being transmitted again, the processor begins to transmit gap data (e.g., data previously omitted during reduced transmission and low signal quality availability). Cached gap data is retrieved from the gap data buffer **30** and passed upstream through the MUX to the transceiver for transmission to the network.

[0022] According to another embodiment, the transmission controller **24** holds data packets in the output buffer **28** until confirmation of receipt (e.g., an ACK) is received. However, when confirmations are not received (e.g., no acknowledgement, or "NACK"), or are received too late (e.g., latency) for the data type, the data is moved to the gap data buffer **30.** The signal quality analyzer, in conjunction with the ACK/NACK and latency analyzer, determines how much signal is available based on the number of packets which are not being successfully transmitted. When less than full bandwidth is available, the transmission controller not only causes some packets to be stored, but also changes the content of the packets. For example, if any bandwidth is available, alerts or packets containing the alerts will be transmitted. If there is a little more signal quality available, the ECG signals will be sent, etc. If the system is operating on reduced signal quality but no packets are going undelivered, then the transmission controller begins increasing the amount of information that is being transmitted. Once sufficient signal quality is detected or reestablished to transmit all of the current data, the transmission controller attempts to obtain even more signal quality in order to transmit the previously omitted gap data from storage in the gap data buffer **28.** In this manner, the gaps in the data at a destination location (e.g., a network server, workstation, etc.) are filled in to provide a complete data history. Thus, the system **10** mitigates typical and unexpected interruptions to the quality of service encountered in shared network environments, and ensures that expected data is presented to the network at a later time when increased signal quality availability is detected.

[0023] FIGURE 2 is an illustration of a graph **40** showing examples of data type hierarchical relationships as a function of signal quality availability. In one embodiment, data communication is performed with knowledge of current throughput for all devices with which a network server or given device is communicating. In cases where communication is impaired due to interference, congestion, or failures, resulting in a limited but extant connection, the devices on the network have a prearranged agreement on what data to stop sending and in what priority to ensure that a certain minimum performance and vigilant patient monitoring is maintained.

[0024] According to the figure, a plurality of points, A-G, are illustrated at different successive levels of decreased bandwidth availability. At point A, full bandwidth is available, and thus all current data is transmitted. For instance, complete data may include, without being limited to, an N-wave physiologic signal (e.g., ECG, heart rate, SpO_2, respiration rate, invasive blood pressure, pressure and flow patterns, etc.,), where N is an integer, all patient parameters, events, alarms, overview data (physiologic data sent from one bed to another), recordings, high fidelity wave snippet data, any available trend uploads, any available document uploads, etc. At point B, where signal quality is somewhat diminished, current data transmission is reduced to the N waveforms, parameter, event, alarm, and overview data. Omitted data is cached for transmission when the signal quality availability increases to the level shown at point A. At point C, signal quality is further diminished, and current data transmission is reduced further, to the exclusion of event data and some of the parameter data. At point D, some of the N waveforms are omitted. Some of the overview data is omitted at point E. At point F, waveforms are downsampled to further reduce signal quality requirements, and overview data is reduced to include only alert and overview information. At point G, only alerts and some of the parameter information is transmitted, since signal quality is severely limited. At each point B-G, any data (e.g., listed in the data set of point A) that is omitted due to reduced signal quality is cached to the gap data buffer for later transmission.

[0025] That is, in "full signal quality" mode, the system is able to receive a superset of physiological waveforms, parameters, alerts, and other application requests. As the signal quality decreases, the system suppresses features and/or locally caches data until the "full" communication signal quality is returned. If further reduction in signal quality is detected, background uploads (gap data and/or print requests) are suspended until communications recover and signal quality availability increases.

[0026] If still further reductions are detected, reductions on the total physiological data set are made (and omitted data is marked as "gap" data) until signal quality recovery is detected. The system **10** reduces to the minimal number of waveforms, parameters and alerts needed to enable patient monitoring. If further reduction is detected, the system sends down-sampled wave data at a lower bit resolution and sends only the primary wave (e.g., ECG), until recovery. In minimal data throughput, the system sends only alerting information and periodic numeric data until recovery. During recovery, the system first restores full fidelity real-time data from all subscribers, then prioritizes cached or gap data with the sending devices.

[0027] The foregoing examples illustrate a data type hierarchy that may be employed in conjunction with the systems and methods described herein. However, it is to be appreciated that the data type hierarchy is not limited to the above-described patient-monitoring data types, but rather may include any classes or types of data (e.g., data from interfaced devices such as ventilators, intravenous medication therapy and feeding pumps, etc.) transmitted over a network in which the systems and or methods described herein are employed. Moreover, the signal quality availability levels need not be evenly or linearly spaced over a total amount of signal quality, but rather may be defined or arranged in any desired manner.

[0028] FIGURE 3 illustrates a flow chart diagram of a method of selectively adjusting data transmission as a function of signal quality availability, in accordance with various aspects described herein. At **60,** a complete or full set of current data is transmitted from a device coupled to a network. At **62,** a available signal quality is assessed. Although depicted as various steps in the method, it will be appreciated that signal quality availability assessment and/or detection is performed continuously as a function of ACKs received by the device for transmitted data packets, as described with regard to Fig. 1. If sufficient signal quality is available (e.g., the device has received ACKs for all or at least a predetermined percentage of all transmitted data packets, and data latency is below the predetermined level for the data types, then the method reverts to **60** and full data transmission is continued.

[0029] If sufficient signal quality is not available, (e.g., a predetermined percentage of transmitted data packets receive NACKs, or do not receive ACKs), or if the data latency is above the predetermined level, then at **64,** data transmission is reduced according to priority indicated by the data type hierarchy, and one or more data types are omitted from the current transmission while the omitted data is cached in a designated buffer. At **66,** the reduced data set is transmitted. Signal quality availability is evaluated with regard to latency and ACKs/NACKs for the reduced data transmission, at **68.** If signal quality is not sufficient for transmission of the reduced data set, then the method reverts to **64,** where further transmission reduction is performed.

[0030] If, at **68,** it is determined that sufficient bandwidth is available for the current transmission volume, then at **69** a determination is made regarding whether sufficient signal quality is present to increase data transmission volume. If not, then the method reverts to **68** and data transmission continues at the current reduced volume. If so, then at **70** transmission data is increased (e.g., by including previously omitted data types) according to the data type hierarchy. The increased data set is transmitted at **72.** Bandwidth availability is reassessed at **74** based on the increased data transmission. If bandwidth is not sufficient, then the method reverts to 64 for data reduction according to the data type hierarchy.

[0031] If signal quality is sufficient at **74,** then at **76** a determination is made regarding whether a complete or full data set is currently being transmitted. If not, then the method reverts to **70** for further increase of the data types included in transmission, as prescribed by the data type hierarchy. If full data is being transmitted, then at **78,** buffered gap data (e.g., previously omitted data stored to the dedicated buffer during reduced data transmission) is transmitted, in addition to transmission of the complete current data set.

[0032] The innovation has been described with reference to several embodiments. Modifications and alterations may occur to others upon reading and understanding the preceding detailed description. It is intended that the innovation be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

Claims

1. A network communication optimization system **(10),** including:

a transceiver **(12)** arranged to transmit and receive data for a plurality of data types over a network;
a signal quality analyzer **(20)** arranged to detect signal quality availability as a function of actual data delivery and application-based latency measurement;
a buffer **(30);** and
a transmission controller **(24)** arranged to

transmit data for all of the plurality of current data types when signal quality availability is above a first predetermined threshold,
selectively reduce current data types to be transmitted by the transceiver **(12)** when signal quality availability drops below each of N successive predetermined thresholds by omitting predefined data types from a transmission signal according to a predetermined data type hierarchy **(26),** wherein N is equal to or greater than 2 and N includes the first predetermined threshold,
cause data relating to the omitted predefined data types to be stored in the buffer **(30),**
selectively increase current data types to be transmitted by the transceiver **(12)** when signal quality availability rises above any of the N successive predetermined thresholds, including the first predetermined threshold, according to the predetermined data type hierarchy **(26),** and
initiate transmission of the omitted data stored in the buffer when the signal quality availability is above the first predetermined threshold in order to fill in data gaps caused

by data omission during reduced data transmission.

2. The system according to claim 1, employed in a hospital network, and further including a central server **(13)** that receives data from the transceiver **(12)** derived from one or more physiologic sensors or devices capable in providing device data or patient physiologic data **(21, 23, 25).**

3. The system according to either one of claims 1 or 2, further including an acknowledgement analyzer **(22)** and a latency analyzer **(27)** that are arranged to evaluate acknowledgements received for transmitted data packets to determine a level of signal quality availability.

4. The system according to claim 2, wherein the transmission controller **(24)** is arranged to vary the amount of current data types transmitted by the transceiver **(12)** from full data transmission when signal quality availability is above the first predetermined threshold down to transmission of alerts when signal quality availability is below the Nth predetermined threshold.

5. The system according to claim 4, wherein the signal quality analyzer **(20)** is arranged to continuously evaluate signal quality availability.

6. The system according to claim 5, wherein the transmission controller **(24)** is arranged to suspend transmission of omitted data stored in the buffer before reducing current data types to be transmitted in response to detected signal quality availability below the first predetermined threshold.

7. The system according to claim 2, wherein the data type hierarchy **(26)** includes a plurality of data types, of which the "alert" data type has a highest priority relative to other data types to ensure that alerts are transmitted even when signal quality availability is below the Nth predetermined threshold.

8. The system according to claim 7, wherein alert-type data includes a minimum number of waveforms, alerts, and parameters for monitoring a patient.

9. The system according to claim 7, wherein the data type hierarchy **(26)** includes, in order of priority from highest to lowest where lower priority current data types are omitted from transmission before higher priority current data types, the following groups of data types:

alert data;
alert reflector overview data and down-sampled waveform data;
overview data;
waveform data;
parameter data and event data; and
trend upload data, local cache data, and document upload data.

10. A method of optimizing data transmission in response to signal quality availability, including:

continuously monitoring signal quality availability on a network;
transmitting data for all of a plurality of current data types when signal quality availability is above a first predetermined threshold;
selectively reducing current data types to be transmitted according to a predetermined data type hierarchy **(26)** to be successively omitted when signal quality availability drops below each of N successive predetermined thresholds, wherein N is equal to or greater than 2 and N includes the first predetermined threshold;
buffering omitted data for later transmission;
selectively increasing current data types to be transmitted according to the predetermined data type hierarchy **(26)** when signal quality availability rises above any of the N successive predetermined thresholds, including the first predetermined threshold; and
transmitting the omitted data when signal quality availability returns to a level above the first predetermined threshold.

11. The method according to claim 10, employed in a hospital network that receives the transmitted data, which comprises information collected by one or more sensors, patient monitors, or physiological data sending device **(21, 23, 25),** and further comprising analyzing acknowledgement and latency information for transmitted data packets to determine signal quality availability.

12. The method according to either one of claims 10 or 11, wherein only patient monitoring alert information is transmitted when signal quality availability is below the Nth predetermined threshold, and
wherein the alert information includes an alarm and a waveform for a monitored parameter causing the alarm.

13. The method according to any one of claims 10, further comprising determining whether signal quality availability has been restored to a level at or above the first predetermined threshold and transmitting all current data types when signal quality availability has been restored to a level at or above the first predetermined threshold.

14. The method according to claim 13, further compris-

ing transmitting buffered omitted data once transmission of all current data types is reinstated and acknowledgements are received for a predefined percentage of current data packets; and terminating transmission of buffered omitted data if acknowledgements for transmitted current data packets drop below a predefined acceptable threshold level.

15. A computer readable medium **(18)** or processor **(16)** carrying software to execute instructions for performing the method according to any one of claims 10-14.

Patentansprüche

1. Netzwerkkommunikation-Optimierungssystem (10) einschließlich:

eines Transceivers (12), der eingerichtet ist, um Daten für eine Vielzahl von Datentypen über ein Netzwerk zu übertragen und zu empfangen;
eines Signalqualitätsanalysators (20), der eingerichtet ist, um Signalqualitätsverfügbarkeit als eine Funktion von tatsächlicher Datenübergabe und anwendungsbasierter Latenzzeitmessung zu erfassen;
eines Zwischenspeichers (30); und
einer Übertragungssteuerung (24), die eingerichtet ist, um

Daten für alle der Vielzahl gängiger Datentypen zu übertragen, wenn Signalqualitätsverfügbarkeit über einem ersten vorbestimmten Schwellenwert liegt,
gängige Datentypen, die durch den Transceiver (12) zu übertragen sind, selektiv zu reduzieren, wenn Signalqualitätsverfügbarkeit unter jeden von N sukzessiven vorbestimmten Schwellenwerten fällt, indem vordefinierte Datentypen gemäß einer vorbestimmten Datentypenhierarchie (26) von einem Übertragungssignal ausgelassen werden, wobei N gleich oder größer als 2 ist und N den ersten vorbestimmten Schwellenwert einschließt,
zu bewirken, dass Daten, die sich auf die ausgelassenen vordefinierten Datentypen beziehen, im Zwischenspeicher (30) gespeichert werden,
gängige Datentypen, die durch den Transceiver (12) zu übertragen sind, gemäß der vorbestimmten Datentypenhierarchie (26) selektiv zu erhöhen, wenn Signalqualitätsverfügbarkeit über einen beliebigen von N sukzessiven vorbestimmten Schwellenwerten, einschließlich des ersten vorbestimmten Schwellenwerts, steigt, und
Übertragung der ausgelassenen Daten, die im Zwischenspeicher gespeichert sind, einzuleiten, wenn Signalqualitätsverfügbarkeit über dem ersten vorbestimmten Schwellenwert liegt, um Datenlücken zu füllen, die durch Datenauslassung während reduzierter Datenübertragung bewirkt werden.

2. System nach Anspruch 1, eingesetzt in einem Krankenhausnetzwerk, und weiter einschließend einen zentralen Server (13), der Daten vom Transceiver (12) empfängt, die von einem oder mehreren physiologischen Sensoren oder Vorrichtungen abgeleitet sind, die imstande sind, Vorrichtungsdaten oder physiologische Daten von Patienten (21, 23, 25) bereitzustellen.

3. System nach einem der Ansprüche 1 oder 2, weiter einschließend einen Bestätigungsanalysator (22) und einen Latenzzeitanalysator (27), die eingerichtet sind, um Bestätigungen, die für übertragene Datenpakete empfangen werden, zu bewerten, um eine Stufe einer Signalqualitätsverfügbarkeit zu bestimmen.

4. System nach Anspruch 2, wobei die Übertragungssteuerung (24) eingerichtet ist, um die Menge an gängigen Datentypen, die durch den Transceiver (12) übertragen werden, von vollständiger Datenübertragung, wenn Signalqualitätsverfügbarkeit über dem ersten vorbestimmten Schwellenwert liegt, bis hinab zur Übertragung von Alarmsignalen, wenn Signalqualitätsverfügbarkeit unter dem N-ten vorbestimmten Schwellenwert liegt, zu variieren.

5. System nach Anspruch 4, wobei der Signalqualitätsanalysator (20) eingerichtet ist, um kontinuierlich Signalqualitätsverfügbarkeit zu bewerten.

6. System nach Anspruch 5, wobei die Übertragungssteuerung (24) eingerichtet ist, um Übertragung von ausgelassenen Daten, die im Zwischenspeicher gespeichert sind, vor Reduzieren gängiger Datentypen, die zu übertragen sind, auszusetzen, als Reaktion auf erfasste Signalqualitätsverfügbarkeit unter dem ersten vorbestimmten Schwellenwert.

7. System nach Anspruch 2, wobei die Datentypenhierarchie (26) eine Vielzahl von Datentypen einschließt, von denen der "Alarmsignal"-Datentyp eine höchste Priorität in Bezug auf andere Datentypen aufweist, um sicherzustellen, dass Alarmsignale übertragen werden, selbst wenn Signalqualitätsverfügbarkeit unter dem N-ten vorbestimmten Schwellenwert liegt.

8. System nach Anspruch 7, wobei die Alarmsignaltypdaten eine Mindestanzahl an Wellenformen, Alarmsignalen und Parametern zur Überwachung eines Patienten einschließen.

9. System nach Anspruch 7, wobei die Datentypenhierarchie (26) in der Reihenfolge von höchster zu geringster Priorität die folgenden Gruppen von Datentypen einschließt, wo gängige Datentypen mit geringerer Priorität vor Datentypen mit höherer Priorität bei der Übertragung ausgelassen werden:

Alarmsignal-Daten;
Alarmsignal-Reflektor-Übersichtsdaten und heruntergerechnete Wellenformdaten;
Übersichtsdaten;
Wellenformdaten;
Parameterdaten und Ereignisdaten; und
Trend-Hochladedaten, Daten zu lokalen Caches und Dokumenthochladedaten.

10. Verfahren zur Optimierung von Datenübertragung als Reaktion auf Signalqualitätsverfügbarkeit, einschließlich:

kontinuierlicher Überwachung von Signalqualitätsverfügbarkeit auf einem Netzwerk;
Übertragen von Daten für alle einer Vielzahl von gängigen Datentypen, wenn Signalqualitätsverfügbarkeit über einem ersten vorbestimmten Schwellenwert liegt;
selektives Reduzieren gängiger Datentypen, die zu übertragen sind, gemäß einer vorbestimmten Datentypenhierarchie (26), die sukzessiv auszulassen sind, wenn Signalqualitätsverfügbarkeit unter jeden von N sukzessiven vorbestimmten Schwellenwerten fällt, wobei N gleich oder größer als 2 ist und N den ersten vorbestimmten Schwellenwert einschließt;
Zwischenspeichern ausgelassener Daten für spätere Übertragung;
selektives Erhöhen gängiger Datentypen, die zu übertragen sind, gemäß der vorbestimmten Datentypenhierarchie (26), wenn Signalqualitätsverfügbarkeit über einen beliebigen von N sukzessiven vorbestimmten Schwellenwerten, einschließlich des ersten vorbestimmten Schwellenwerts, steigt; und
Übertragen der ausgelassenen Daten, wenn Signalqualitätsverfügbarkeit zu einer Stufe über dem ersten vorbestimmten Schwellenwert zurückkehrt.

11. Verfahren nach Anspruch 10, eingesetzt in einem Krankenhausnetzwerk, das die übertragenen Daten empfängt, die Informationen umfassen, die durch einen oder mehrere Sensoren, Patientenüberwachungen oder Sendevorrichtung physiologischer Daten (21, 23, 25) gesammelt werden, und weiter umfassend Analysieren von Bestätigungs- und Latenzzeitinformationen für übertragene Datenpakete, um Signalqualitätsverfügbarkeit zu bestimmen.

12. Verfahren nach einem der Ansprüche 10 oder 11, wobei nur Patientenüberwachung-Alarmsignalinformationen übertragen werden, wenn Signalqualitätsverfügbarkeit unter dem N-ten vorbestimmten Schwellenwert liegt, und
wobei die Alarmsignalinformationen ein Alarmsignal und eine Wellenform für einen überwachten Parameter, der das Alarmsignal bewirkt, einschließen.

13. Verfahren nach einem der Ansprüche 10, weiter umfassend Bestimmen, ob Signalqualitätsverfügbarkeit auf eine Stufe am oder über dem ersten vorbestimmten Schwellenwert wiederhergestellt wurde und Übertragen aller gängigen Datentypen, wenn Signalqualitätsverfügbarkeit auf eine Stufe am oder über dem ersten vorbestimmten Schwellenwert wiederhergestellt wurde.

14. Verfahren nach Anspruch 13, weiter umfassend Übertragen von zwischengespeicherten ausgelassenen Daten, nachdem die Übertragung aller gängigen Datentypen wiedereingesetzt ist und Bestätigungen für einen vordefinierten Anteil von gängigen Datenpaketen empfangen werden; und Beenden der Übertragung von zwischengespeicherten ausgelassenen Daten, wenn Bestätigungen für übertragene gängige Datenpakete unter eine vordefinierte akzeptable Schwellenwertstufe fallen.

15. Computerlesbares Medium (18) oder Prozessor (16), der/das Software zum Ausführen von Anweisungen zum Durchführen des Verfahrens nach einem der Ansprüche 10-14 trägt.

Revendications

1. Système d'optimisation de communication réseau (10), incluant :

un émetteur-récepteur (12) conçu pour transmettre et recevoir des données pour une pluralité de types de données sur un réseau ;
un analyseur de qualité de signal (20) conçu pour détecter une disponibilité de qualité de signal en fonction d'une fourniture de données actuelle et d'une mesure de latence basée sur une application ;
une mémoire tampon (30) ; et
un dispositif de commande de transmission (24) conçu pour

transmettre des données pour toute la pluralité de types de données actuels lorsqu'une disponibilité de qualité du signal est

supérieure à un premier seuil prédéterminé, réduire sélectivement des types de données actuels à transmettre par l'émetteur-récepteur (12) lorsqu'une disponibilité de qualité du signal passe en dessous de chacun de N seuils prédéterminés successifs en omettant des types de données prédéfinis provenant d'un signal de transmission selon une hiérarchie de types de données prédéterminée (26), N étant égal ou supérieur à 2 et N incluant le premier seuil prédéterminé,
amener des données relatives aux types de données prédéfinis omis à être stockées dans la mémoire tampon (30),
augmenter sélectivement des types de données actuels à transmettre par l'émetteur-récepteur (12) lorsqu'une disponibilité de qualité de signal dépasse l'un quelconque des N seuils prédéterminés successifs, y compris le premier seuil prédéterminé, conformément à la hiérarchie de types de données prédéterminée (26), et
lancer une transmission des données omises stockées dans la mémoire tampon lorsque la disponibilité de qualité de signal est supérieure au premier seuil prédéterminé afin de combler des vides de données provoqués par une omission de données au cours d'une transmission de données réduite.

2. Système selon la revendication 1, utilisé dans un réseau hospitalier, et incluant en outre un serveur central (13) qui reçoit des données de l'émetteur-récepteur (12) dérivées d'un ou plusieurs capteurs ou dispositifs physiologiques capables de fournir des données de dispositif ou des données physiologiques de patient (21, 23, 25).

3. Système selon l'une quelconque des revendications 1 ou 2, incluant en outre un analyseur d'accusés de réception (22) et un analyseur de latence (27) qui sont conçus pour évaluer des accusés de réception reçus pour des paquets de données transmis afin de déterminer un niveau de disponibilité de qualité de signal.

4. Système selon la revendication 2, dans lequel le dispositif de commande de transmission (24) est conçu pour faire varier la quantité de types de données actuels transmis par l'émetteur-récepteur (12) d'une transmission complète de données lorsqu'une disponibilité de qualité de signal est supérieure au premier seuil prédéterminé jusqu'à une transmission d'alertes lorsqu'une disponibilité de qualité du signal est inférieure au Nième seuil prédéterminé.

5. Système selon la revendication 4, dans lequel l'analyseur de qualité de signal (20) est conçu pour évaluer en continu une disponibilité de qualité de signal.

6. Système selon la revendication 5, dans lequel le dispositif de commande de transmission (24) est conçu pour suspendre une transmission de données omises stockées dans la mémoire tampon avant de réduire des types de données actuels à transmettre en réponse à une disponibilité de qualité de signal détectée inférieure au premier seuil prédéterminé.

7. Système selon la revendication 2, dans lequel la hiérarchie de types de données (26) comprend une pluralité de types de données, dont le type de données « alerte » qui a une priorité la plus élevée par rapport aux autres types de données afin de garantir que des alertes sont transmises même lorsqu'une disponibilité de qualité de signal est inférieure au Nième seuil prédéterminé.

8. Système selon la revendication 7, dans lequel des données de type alerte incluent un nombre minimal de formes d'onde, d'alertes, et de paramètres pour surveiller un patient.

9. Système selon la revendication 7, dans lequel la hiérarchie de types de données (26) inclut, par ordre de priorité allant de la plus élevée à la plus faible, les types de données actuels de priorité inférieure étant exclus de la transmission avant les types de données actuels de priorité supérieure, les groupes de types de données suivants :

données d'alerte ;
données de vue d'ensemble réflectrices d'alerte et données à forme d'onde sous-échantillonnée ;
données de vue d'ensemble ;
données de forme d'onde ;
données de paramètre et données d'événement ; et
données de téléchargement de tendance, données de mémoire cache locale, et données de téléchargement de document.

10. Procédé d'optimisation d'une transmission de données en réponse à une disponibilité de qualité de signal, incluant de :

surveiller en continu une disponibilité de qualité de signal sur un réseau ;
transmettre des données pour toute une pluralité de types de données actuels lorsqu'une disponibilité de qualité de signal est supérieure à un premier seuil prédéterminé ;
réduire sélectivement des types de données actuels à transmettre selon une hiérarchie de types

de données prédéterminée (26) à omettre successivement lorsqu'une disponibilité de qualité de signal tombe en dessous de chacun de N seuils prédéterminés successifs, N étant égal ou supérieur à 2 et N comprenant le premier seuil prédéterminé ;
mettre en mémoire tampon des données omises pour une transmission ultérieure ;
augmenter sélectivement des types de données actuels à transmettre en fonction de la hiérarchie de types de données prédéterminée (26) lorsqu'une disponibilité de qualité de signal s'élève au-dessus de l'un quelconque des N seuils prédéterminés successifs, y compris le premier seuil prédéterminé ; et
transmettre les données omises lorsqu'une disponibilité de qualité de signal revient à un niveau supérieur au premier seuil prédéterminé.

11. Procédé selon la revendication 10, utilisé dans un réseau hospitalier recevant les données transmises, qui comprend des informations collectées par un ou plusieurs capteurs, des moniteurs de surveillance de patient, ou un dispositif d'envoi de données physiologiques (21, 23, 25), et comprenant en outre d'analyser des informations d'accusés de réception et de latence pour des paquets de données transmis afin de déterminer une disponibilité de qualité de signal.

12. Procédé selon l'une quelconque des revendications 10 ou 11, dans lequel seules des informations d'alerte de surveillance de patient sont transmises lorsqu'une disponibilité de qualité de signal est inférieure au Nième seuil prédéterminé, et
dans lequel les informations d'alerte incluent une alarme et une forme d'onde pour un paramètre surveillé provoquant l'alarme.

13. Procédé selon l'une quelconque des revendications 10, consistant en outre à déterminer si une disponibilité de qualité de signal a été restaurée à un niveau égal ou supérieur au premier seuil prédéterminé et à transmettre tous les types de données actuels lorsqu'une disponibilité de qualité de signal a été restaurée à un niveau égal ou supérieur au premier seuil prédéterminé.

14. Procédé selon la revendication 13, comprenant en outre la transmission de données omises mises en mémoire tampon une fois qu'une transmission de tous les types de données actuels est rétablie et que des accusés de réception sont reçus pour un pourcentage prédéfini de paquets de données actuels ;
et la cessation d'une transmission de données omises mises en mémoire tampon si des accusés de réception pour des paquets de données actuels transmis passent en dessous d'un niveau de seuil acceptable prédéfini.

15. Support lisible par ordinateur (18) ou processeur (16) contenant un logiciel pour exécuter des instructions pour effectuer le procédé selon l'une quelconque des revendications 10 à 14.

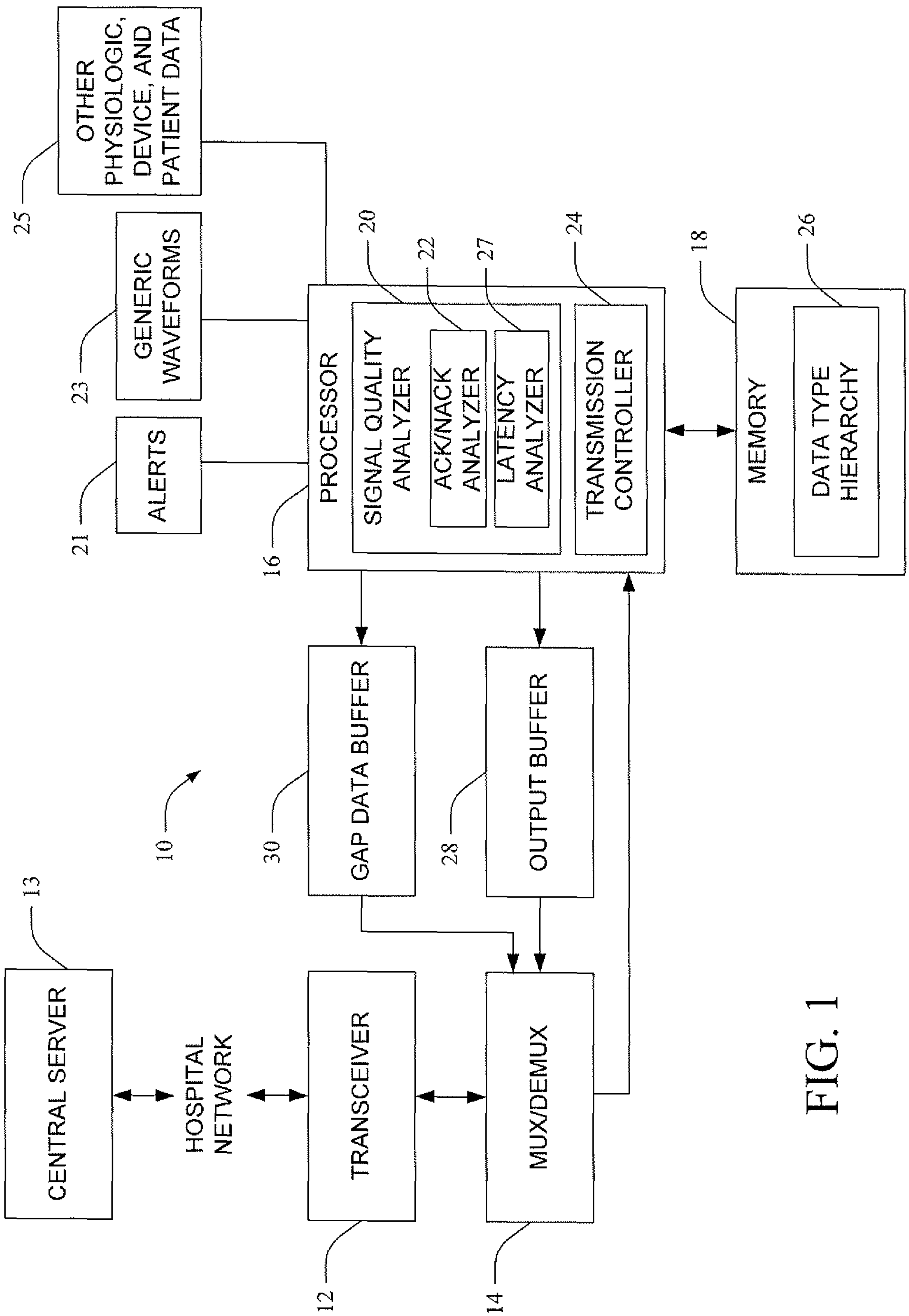
CENTRAL SERVER
13
HOSPITAL NETWORK
TRANSCEIVER
12
MUX/DEMUX
14
10
GAP DATA BUFFER
30
OUTPUT BUFFER
28
ALERTS
21
GENERIC WAVEFORMS
23
OTHER PHYSIOLOGIC, DEVICE, AND PATIENT DATA
25
PROCESSOR
16
SIGNAL QUALITY ANALYZER
20
ACK/NACK ANALYZER
22
LATENCY ANALYZER
27
TRANSMISSION CONTROLLER
24
MEMORY
18
DATA TYPE HIERARCHY
26

FIG. 1

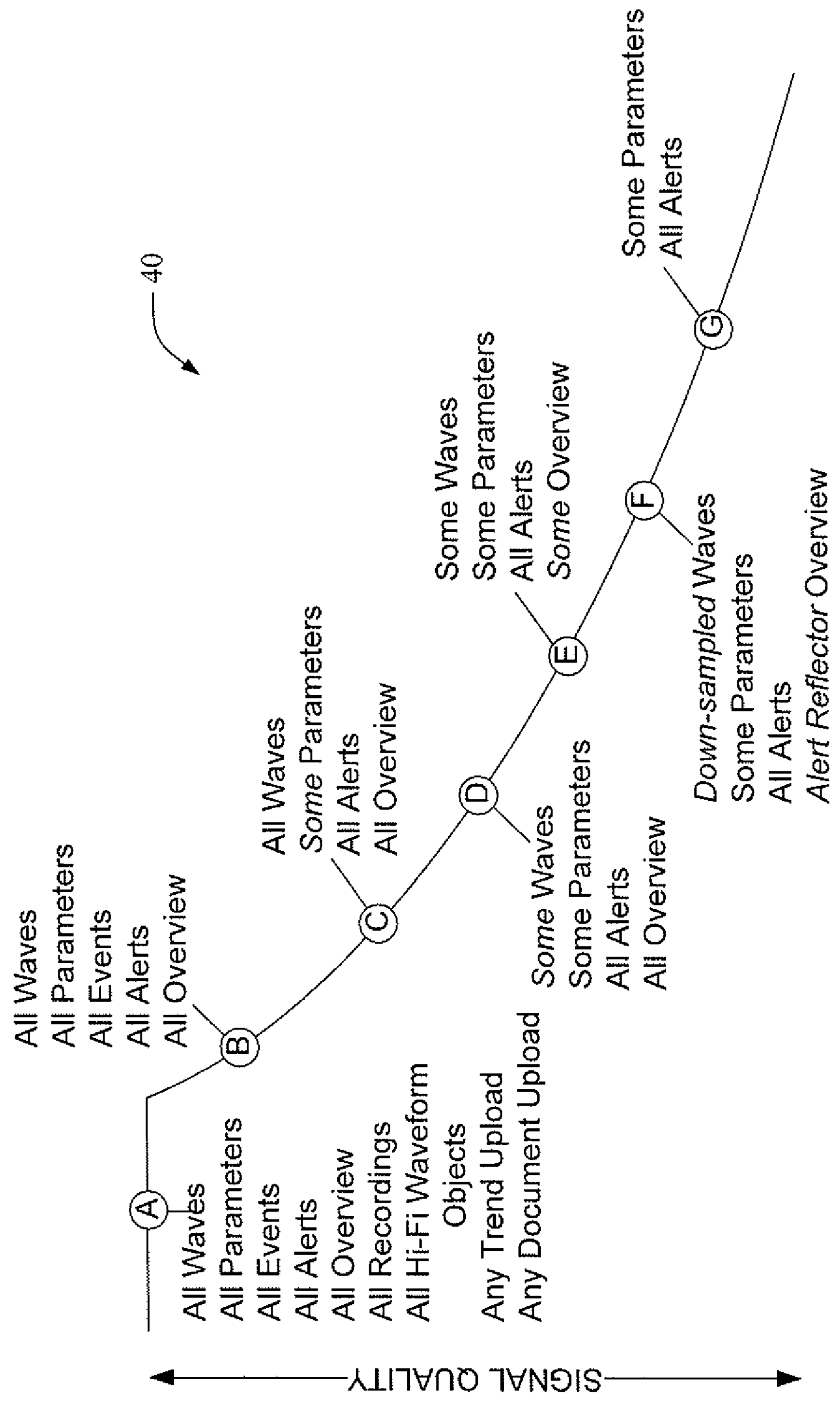
40
SIGNAL QUALITY
A
All Waves
All Parameters
All Events
All Alerts
All Overview
All Recordings
All Hi-Fi Waveform Objects
Any Trend Upload
Any Document Upload
B
All Waves
All Parameters
All Events
All Alerts
All Overview
C
All Waves
Some Parameters
All Alerts
All Overview
D
Some Waves
Some Parameters
All Alerts
All Overview
E
Some Waves
Some Parameters
All Alerts
Some Overview
F
Down-sampled Waves
Some Parameters
All Alerts
Alert Reflector Overview
G
Some Parameters
All Alerts

FIG. 2

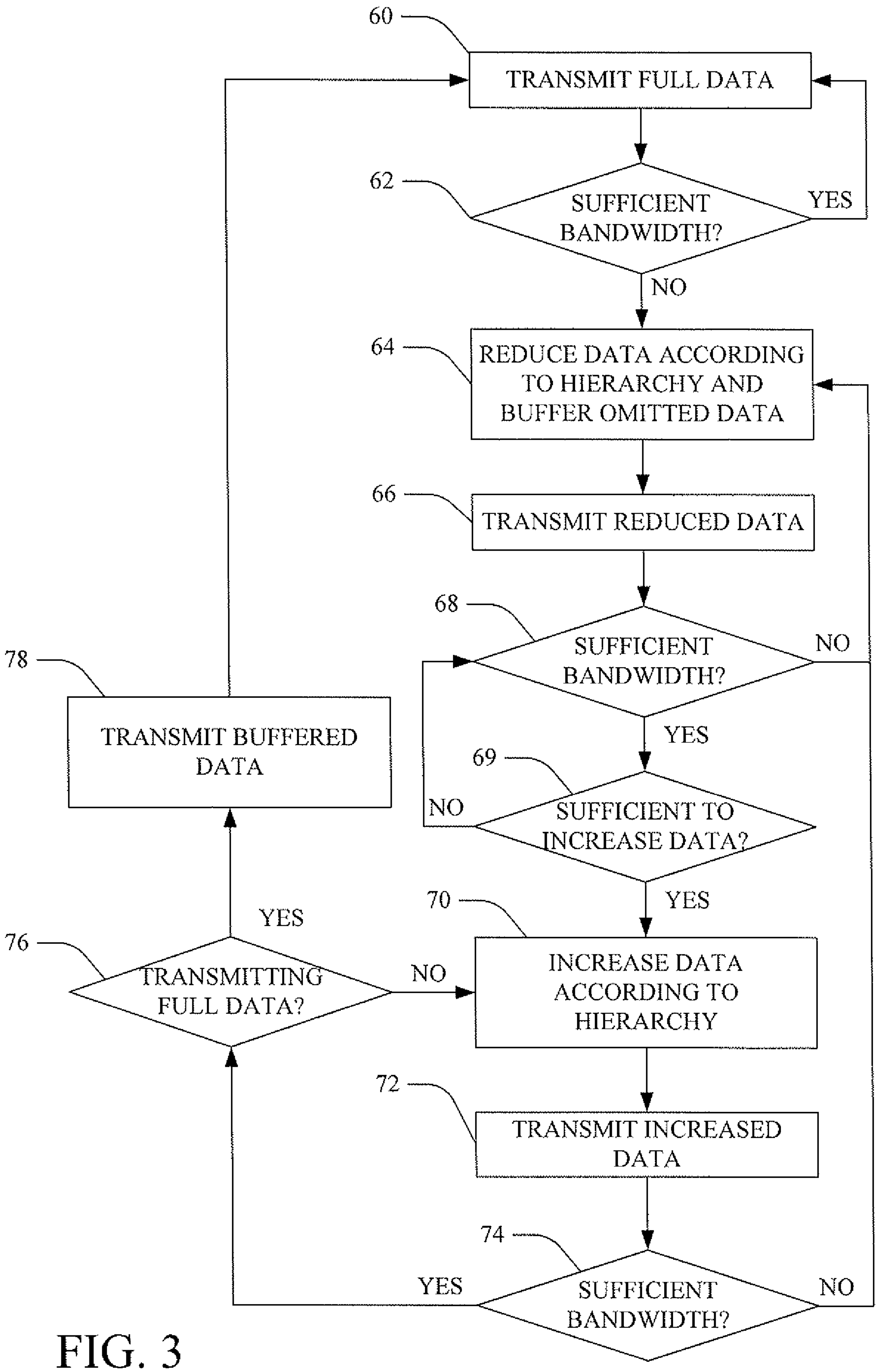
60
TRANSMIT FULL DATA
62
SUFFICIENT BANDWIDTH?
YES
NO
64
REDUCE DATA ACCORDING TO HIERARCHY AND BUFFER OMITTED DATA
66
TRANSMIT REDUCED DATA
68
SUFFICIENT BANDWIDTH?
NO
YES
69
SUFFICIENT TO INCREASE DATA?
NO
YES
70
INCREASE DATA ACCORDING TO HIERARCHY
72
TRANSMIT INCREASED DATA
74
SUFFICIENT BANDWIDTH?
YES
NO
76
TRANSMITTING FULL DATA?
YES
NO
78
TRANSMIT BUFFERED DATA

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2005002379 A **[0005]**
- WO 0011841 A **[0005]**

专利名称(译)	基于可用但可变的信号质量优化生理监测		
公开(公告)号	EP2250771B1	公开(公告)日	2019-04-24
申请号	EP2009716104	申请日	2009-02-02
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
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[标]发明人	GROSS BRIAN		
发明人	GROSS, BRIAN		
IPC分类号	H04L12/26 H04L12/801 H04L12/825 H04L12/841 A61B5/00		
CPC分类号	H04L47/10 G16H10/60 G16H40/20 H04L41/0896 H04L43/0852 H04L47/14 H04L47/25 H04L47/283		
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其他公开文献	EP2250771A1		
外部链接	Espacenet		

摘要(译)

当通过医院网络传输患者数据时，数据类型被优先化为数据类型层次结构（26），该数据类型层次结构用于按照在信号质量降低期间传输的关键性的顺序对数据类型进行排序。随着信号质量的降低，从传输中省略不太关键的数据类型并将其存储到间隙数据缓冲器中以便以后传输。随着信号质量的恢复，不太重要的数据类型将恢复到当前的数据传输。一旦在当前传输期间恢复所有数据类型，就发送先前省略的间隙数据以填充诸如网络服务器的接收设备中的间隙，以确保向网络和/或与其耦合的其他设备提供完整的数据集。

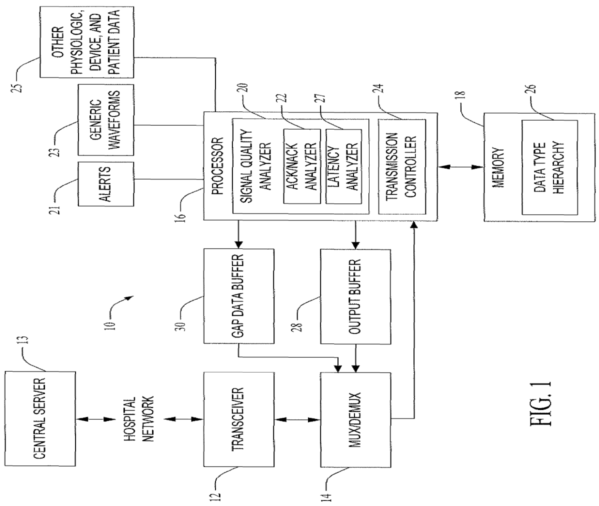

FIG. 1