A Medical Services Middleware System for BAN

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Abstract. In the age of big data, there is an important research to storage, monitors and analyze the scale of bodies' signs with the wireless body area network. A medical service middleware system for the purpose of the remote medical monitoring is presented in this paper. According to the wireless body area network, a transparent and efficient message processing middleware is designed in this system. Combined the message middleware technology with the server cluster technology, this system will build a big data monitoring and analysis platform for remote medical monitoring.

1. Introduction

As the aging population in many countries and the rising cost of the health care, the current health care service already can't meet the demand and it's urgent to upgrade. The fixed devices and wired connection is equipped in the traditional health care system. This approach greatly affects the patient's daily life, and at the same time, medical devices need high cost of the deployment and maintenance. In addition, it's quite difficult for the early prevention of some diseases and the long-term observation with the current health care system. In order to solve these problems, a new wireless sensor network has emerged: Wireless Body Area Network (WBAN) [1]. As an important branch of the Wireless Sensor Network (WSN), the wireless body area network is focus on providing support to all aspects of people's daily lives. Especially, in a variety of areas, it can support continuous, real-time, non-contact monitoring of the bodies' physiological conditions at any time and any place. This makes it possible to provide remote medical monitoring, at the same time, WBAN will also significantly improve the quality of health care.

At present, there are many software middleware research project and products be put forward by many universities and research institutions. For example, Agustinus Borgy Waluyo has designed a multi-sensor, plug and play middleware for the terminal nodes in the body area network [2]; Abousharkh Maha has designed a middleware architecture based on the service [3]; and so on. However, these projects focus on the function and services of the terminal nodes, and are careless in the server works, such as the platform built for processing the message communication and data exchange of the large-scale human bodies' signs. As growing demand of people, the server load will be heavier. Therefore, this paper focused on the processing of the large-scale data with the server, put forward a medical service middleware system. The system architecture and the communication architecture and logic architecture between the client and the server will be given in the text. And a transparent, efficient message processor will be designed for the purpose of the remote medical monitoring.

2. Medical Service Middleware System

In this paper, the medical service middleware system is also based on the basic system architecture of the wireless body area network (Figure 1). The main difference is that after receiving the data packages transmitted from personal terminals, the medical service middleware system will parse the packages and convert the data, and then delivered to different centers and services according to the data contents. This will guarantee the centers and services' functional independence, and ensure the flexibility of the data transmission.

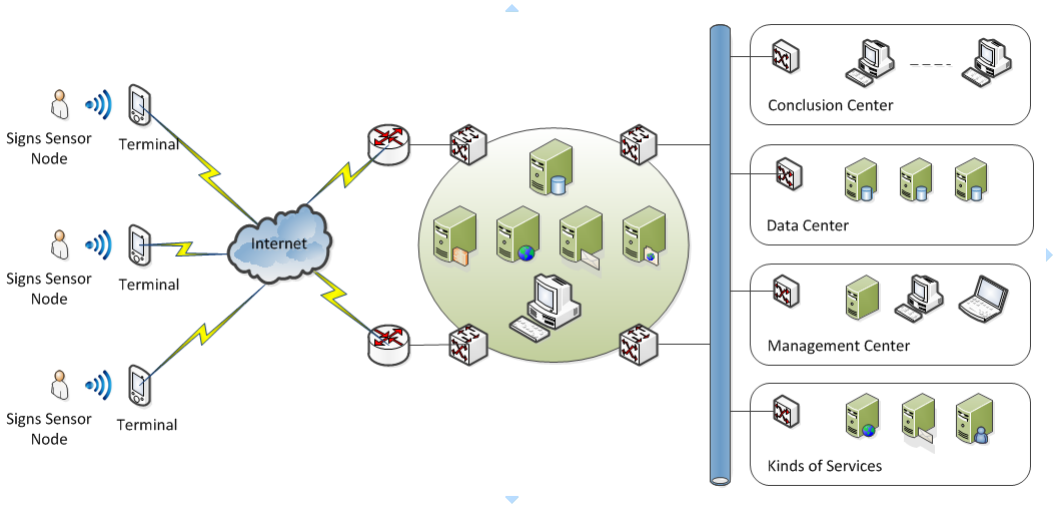

Fig. 1 the basic architecture of the medical service middleware system

The personal terminal, according to the API provided by the middleware server , sends the data packages to the middleware server, through the networks (including Wi-Fi, 3G, 4G, GPRS, etc., and other wired networks). The middleware server receives the packages and makes a series of operation, such as message processing and data conversion, and then delivers the message to the different processing center/department, depended on the needs of the data contents. The centers/departments in the information center will deal the data with their own centers'/departments' requirements. Meanwhile, the communication between the client and the server, the server and the information center is bidirectional. In other words, the information center can send commands to the middleware server to obtain the desired services or data. And the client may get the personal information and subscript the related services from the middleware server.

Facing the packages continuously transmitted from the scale of personal terminals, a single server certainly cannot load. Therefore, the medical service middleware system will adopt the way of multiple server clusters to deploy. In order to ensure that when a few servers fail, the clients connected to these servers can work well and would be not affected, they should have the ability to connect to the other servers that are in normal working condition, when they find the present connecting server has failed. Meanwhile, each server should be able to communicate with the services and applications in the upper layer (Figure 2).

At the same time, the load balancing of the cluster's multiple servers will also be a vital part of the medical service middleware system. So there need to take some technology, reasonably distribute the load pressure on each server, thus to achieve a dynamic equilibrium, to relieve the pressure of the master server.

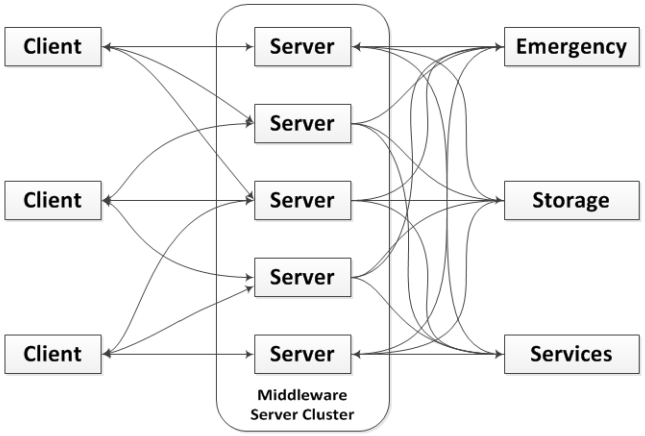

Fig. 2 the logic structure of the medical service middleware system

3. Key point of the middleware system design

The design goals of medical service middleware system are to be able to provide a large-scale, real-time messaging and data exchange, and have a higher system performance. The personal terminal nodes of the body area network can communicate directly and transparently through the open API of the medical service middleware system. Other Internet devices (cell phones, computers, etc.) can also communicate message and exchange data through the open API of the medical service middleware system to obtain the desired contents. It not only achieves the transparent communications between the body area network devices, but greatly simplifies the development of body area network application systems and reduces the cost.

Therefore, the medical service middleware system should achieve the following key points:

(1) High performance: the characteristics of the remote medical monitoring determine that the personal terminal in the wireless body area network needs to be continuously collecting the information of the human body signs. Although the personal terminals will make a preliminary data filtering, but the amount of data is not small. Suppose after collected and processed, the amount of data is 1KB per second in one personal terminal, then the amount of data generated by one day will reach 86400KB in one personal terminal. The amount of data generated from a lot of personal terminal, there is no doubt that considerable requirements are put forward for the performance of the server. Therefore, for a single server, multithread should be provided to process multiple personal terminals' requests; for the entire server cluster, there should be able to provide a good automatic load balancing function.

(2) Transparency: the personal terminals and information center just need to call the API of the medical service middleware system according to their needs, and then they can communicate messages, exchange data directly and transparently, without the need to understand the whole process of the entire information transmissions.

(3) Reliability: The communication between personal terminals and the server is mainly based on the wireless network. The wireless network cannot guarantee to provide highly reliable communications because of its own characteristics. It's fatal for remote medical monitoring. Therefore, the medical service middleware system must support both synchronous and asynchronous message transmissions and the retransmissions the message in particular situations.

4. Design of the Message Processor

In general, the communication between applications is accomplished through the inter-process communication. The information transfer among different processes, we collectively called message. It is the basic unit of communication and data exchange between processes. A message is usually composed of the message descriptor and the message body:

(1) The message descriptor: it is used to describe the message's attributes, such as the source address, destination address, the message type, life cycle, priority and so on.

(2) The message body: it is generally the data of provided by the applications, such as the human bodies' signs that terminal collected, human health assessment report that consultation center generated and so on. It can be empty in some special cases.

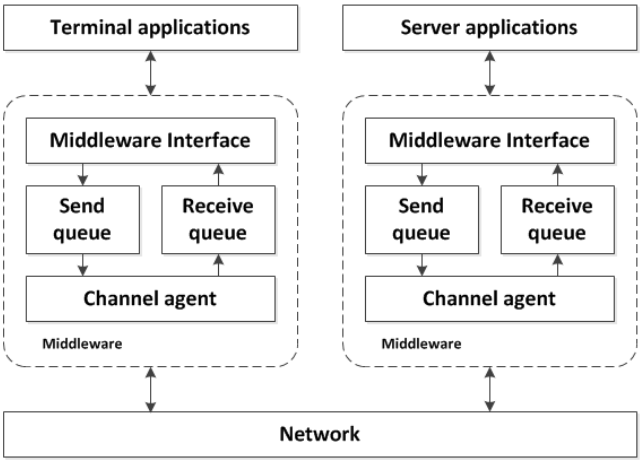

Fig. 3 the architecture of the message processor

Seen from figure 3, the communication between the terminal and the server applications will be competed through a message oriented middleware. When the terminal application delivers the message to the message middleware, the message middleware will put the message into the send queue. And then the thread, which is responsible for sending messages, takes out the message from the send queue, and sends it to the server according to the message descriptors. When the thread, which is responsible for receiving messages in the server's message middleware, receives a new message, it will put the message into the receive queue. The application of the server will take out the message from the receive queue for further processing. Similarly, the server's application can send a message to the terminal's application by the message oriented middleware.

For the remote medical monitoring, the loss of several monitoring data may not affect the patient's health assessment. But if a long period of monitoring data or the emergency data was lost, that would be considerable effects on the patient's health assessment. Although the figure 4 has showed the overall architecture of the message processor, but both the computer and the network is not infallible. The hardware failures and software failures of the computer, the loss of the network's packets and son on, will affect the normal work of the message processor. Therefore, there needs to make some further design for the message processor:

(1) The use of the request/response message: to the current computer technology, the message is not necessarily accurately delivered to the destination. Therefore, it is necessary to use the request/ response message. For example, the message sender sends a message to the message receiver, when the message receiver receives the message, it will send a reply message to the message sender, said it had received the message, and then the message could be remove from the send queue. And if the message sender has been not received the reply message, the message can be repeated. In this way, it can ensure that the message has been successfully delivered.

(2) The priority of the message: generally speaking, the messages in the queue are processed according to the mechanism of first in first out. There are no differences among the message priorities. In the remote medical monitoring, there must be some emergency situations. In general, the state of human bodies' signs is constant in the short time. When a patient has a fever, the physiological parameters (such as body temperature, blood pressure, heart rate, respiration rate) must be correspondingly increased. In order to make an urgent message to be sent in advance, the message must be able to carry on the classification, to ensure that the high priority message is priority.

(3) Data Exchange: XML is a kind of "extensible markup language" and it has the self-described semi-structured data description. There is no doubt that XML has the advantage because of its extensibility, self-description and the other characteristics. XML has the following main advantages: cross-platform, easy to understand and be able to descript the structured data, semi-structured data

and even unstructured data, and so on. Therefore, XML is a simple, open, widely accepted data standard. And it will become very convenient to carry out data exchange and pressing with XML.

(4) The message's persistence and the queue's depth: suppose there are some important message must be delivered in the current queue, and the program just appears fault, these messages will be permanently lost. In order to prevent this happening, message processor should be able to make a backup for the important messages. The queue's depth is the maximum number of the messages the queue could cache. There may be full queue situation, and it needs some specific method.

5. Summary

How to storage, monitor and analyze the scale of human signs will be an important research direction in the big data age. A medical service middleware system is proposed in this paper. It combines the message middleware technology and the server cluster technology. And it shows the system architecture, the communication architecture and logic architecture between the client and the server. According to the characteristics of the body area network, a transparent, high-performance, high-reliability message processor is designed to make a greater platform for the remote medical monitoring. With the development of the society, the constantly updated technology, remote medical monitoring will be possible in one day.

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