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Internet of Things Healthcare Cloud System Based on IEEE 802.15.4

[1,2]Ruixia Liu, [2]Yinglong Wang and [2]Minglei Shu
[1]College of Information Science and Engineering, Shandong University of Science and Technology, 266590, Qingdao, China
[2]Shandong Provincial Key Laboratory of Computer Network, Shandong Computer Science Center, 250014, Jinan, China

Abstract: Recently researchers are spending great efforts on the wireless Body Sensor Network (BSN) for medical applications such as monitoring of heart beats, body temperature, blood pressure, pulse of the aging people both in hospital or at home. The combination of BSN and mobile communications and cloud comuting makes medical applications for a large population possible. In this paper, based on the CSMA/CA protocol, a kind of adaptive binary backoff algorithm is proposed and applied to the internet-based healthcare cloud systems, which enables longer survivability time of BSN than binary backoff algorithm. Simulation results are included to illustrate the effectiveness of the proposed control scheme. Moreover this algorithm implemented in this Internet of things health care cloud system.

Key words: CSMA/MA, medium access control, healthcare, body sensor network, IEEE802.15.4

INTRODUCTION

The aging people's physical condition monitoring is a key issue for health and disease management. The use of BSN makes this task seamless and easy. BSN have recently been identified as a promising technology enabling a range of applications in health and well-being (Otal *et al*., 2009). Bae *et al*. (2012) presented that BSN is an emerging technology, which can combine healthcare and consumer electronic applications around the human body. Qingjin *et al*. (2012) proposed a Qos TDMA protocol named Q-TDMA for BSN. Lee and Chung (2009) introduced numbers of patients suffering for age related diseases are increasing with the fast increase in aging population around the world. Wireless health monitoring systems using health sensors in-home and out of hospital may assist residents and caregivers by providing invasive and non-invasive continuous health monitoring with minimum interaction of doctors and patients. Recent advances in the development of smaller and more precise sensors have made it possible to apply a wide range of wireless elder monitoring systems in natural environments, such as at work, at home and even in motion. Our proposed health care system realizes the solution of aging people.

The rest of this study is organized as follows. The next section follows with a brief overview of the design the remote health care monitoring cloud system based on Internet of things, which includes the System Architecture design. Then proposes a novel adaptive CSMA/CA mechanism based on the low rate IEEE 802.15.4. We after that present simulation results and System implementation. Finally conclude the paper and outlook in the future.

SYSTEM ARCHITECTURE

Based on Internet of things and cloud computing, this healthcare system is composed of a set of small sensors with minimal hardware capacity, attached or implanted into the body of the patient measuring parameters such as temperature, humidity, blood pressure, pulse, ECG and so on, faced to personal and family health perception and management system. In this system, body sensor network is the lowest leve but also the critical layer. The sensing data collected by the body area network is transmitted to the cloud platform through Ethernet or GPRS communication mode and the healthcare institutions or medical professionals can analyze the sensing data and give feedback of these information to the user timely. In emergency situation, the system can automatically send alarm messages to the doctors or the children of the party. Further, through the integration extraction, tap of these data, the agencies, medical institutions and health care institutions, can statistic analysis of the health situation of the people, health management organizations. Fig .1 shows the architecture of the system.

Corresponding Author: Ruixia Liu, College of Information Science and Engineering, Shandong University of Science and Technology, Qingdao, China

Fig. 1: System architecture

MECHANISM OF CSMA/CA DEISIGN

CSMA/CA mechanism: The transport layer of the system adopts IEEE802.15.4 protocol standards. In the IEEE 802.15.4 Media Access Control (MAC) layer, CSMA-CA slot collision avoidance mechanism and fixed-bandwidth communication services are used to a dedicate timeslot reserved avoid competition when sending data and conflict, to a data transfer mechanism is fully recognized, each transmitted data packet must wait for confirmation of the recipient. CSMA/CA mechanism have its real-time nature, scalability, support for emergency communications, to avoid the hidden terminal exposed terminal problems, etc. Thus it is obtained more and more attention by the wireless network researchers.

Collision avoidance CSMA/CA mechanisms is a major channel access protocol of wireless networks. The main idea is to compete channel when the node sends data. If it encounters collision when sending data, it will resend data with some strategy till the data is sent successfully or abandon. The strategy is usually binary exponential backoff algorithm. Each node maintains three parameters: Number of Backoffs (NB), Contention Window (CW) and Backoff Exponent (BE). The efficiency of CSMA/CA mechanism is inefficient when encountering the conflicts, due to multiple devices, which share the same channel in star-topology. However, body sensor network only have several nodes, collision rate and backoff period are still relatively high and long. In this paper, we analyze a CSMA/CA mechanism for a one-hop, star-topology beacon-enabled 802.15.4 and propose a novel adaptive CSMA/CA mechanism. This algorithm can dynamically adjust backoff exponent in real time, thereby improving system throughput, reducing transmission delay.

CSMA/CA mechanism design: The proposed adaptive backoff algorithm is based on three important principles: First, the device provides a higher backoff exponent range, to reduce the the probability of the number of backoff period of the device and of the probe channel device the same value.

Second, dynamic processing of the minimum backoff exponent constant (macMinBE). In this algorithm, the minimum backoff exponent constant is a variable, so when there is data to be transmitted, all the equipments can not enable the same backoff exponent.

Thirdly, The algorithm usually dynamically adjusts the parameters (macMinBE) according to each node share of network traffic, taking into account only data transmission equipment. Therefore, when a node first starts this algorithm, the backoff index is still defined using the default minimum backoff exponent (macMinBE).

Based on the CSMA, by increasing the RTS (8 bytes) and CTS (6 bytes) handshake data packet to inform the neighbor nodes that the channel will be occupied for the period contained. If there is a data packet to be transmitted, it first listens to channel, to determine whether the current channel is occupancied by other nodes. If the channel is busy, the node random backoff time. Until the channel is idle, the node sends an RTS handshake signal to the receiving node. After the receiving node successfully receives a RTS, it returns a

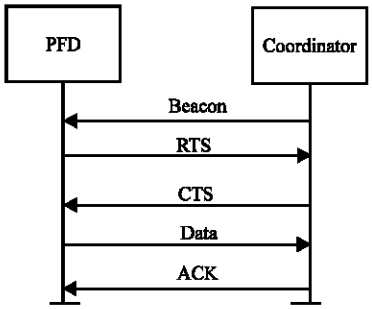

Fig. 2: RTS/CTS

CTS signal to the transmitting node. It is also notify surrounding node after a period of time within the channel will be occupied, so that other nodes retreat. Since the cost of RTS and CTS signals itself is small, so largely to avoid the conflict between information packets, even if a conflict between the control signal, the price has also repeatedly sending small, that is a small price in return for sending a high success rate Fig. 2.

The adaptive BE design still retains the initial of macMinBE in CSMA/CA algorithm, but through a number of beacon frame interval, each node of network traffic contention to dynamically adjust the back-off index macMinBE, the sensor nodes to the network condition dynamically select an appropriate backoff range. After this optimization, increase network throughput and reduce the network load Fig. 3.

When the node can not send data successfully after many times, it will change their macMinBE value. At first the transmission node will addopt the default value of 3 macMinBE, but with the dynamic changes of the network, each node will contend with different network traffic, terminal node will send success or failure was based on the number to increase or decrease its backoff exponent macMinBE. The next transfer node will use the new macMinBE.

According to our forecasts and analysis, the algorithm does not interfere with the original CSMA/CA mechanism, which lead to high efficiency. The algorithm, which occupies more network traffic (increase network congestion) of the nodes, utilizes the increased backoff value (macMinBE), otherwise the reduced back-off (macMinBE). The nodes cccupied more network traffic indicates that the node access channel frequency is relatively high, so using exponential backoff value larger than those of nodes may apply a smaller macMinBE.

SIMULATION RESULTS AND DISCUSSIONS

In short, the adaptive BE design still retains the initial value of macMinBE, but through a certain number of

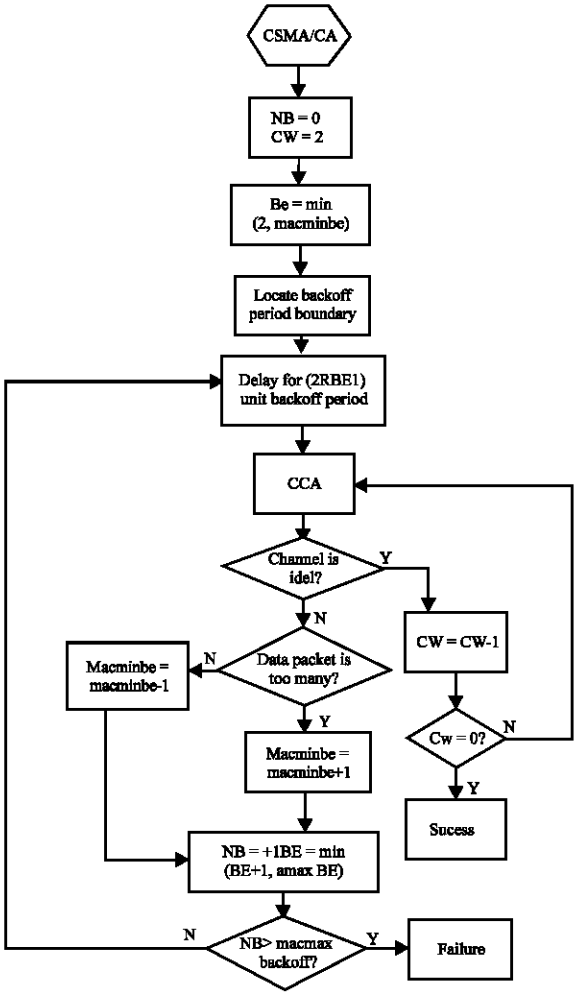

Fig. 3: Adaptive CSMA/CA alogorithm

beacon frame interval for each node of network traffic contention dynamically select an appropriate backoff range. This algorithm assigned a larger backoff exponent value for the nodes with more bandwidth occupied, such as the ECG. On the contrary, this design assigned a lower backoff, when a large amount of traffic in the network, nodes more prone to conflict. because this optimization, increases network throughput and reduces the network load from the Fig 4. On the other hand, when network traffic is low, the possibility of conflicts of each node is small, this adaptive BE design change is relatively small you may not have much access to the original program.

SYSTEM IMPLEMENT

As shown in Fig. 5, it depicts the electrocardiogram and oxygen, each test again ECG, there are hundreds of packets, add up 14k bytes, through this wireless transmission mechanism to cloud platform. However, such

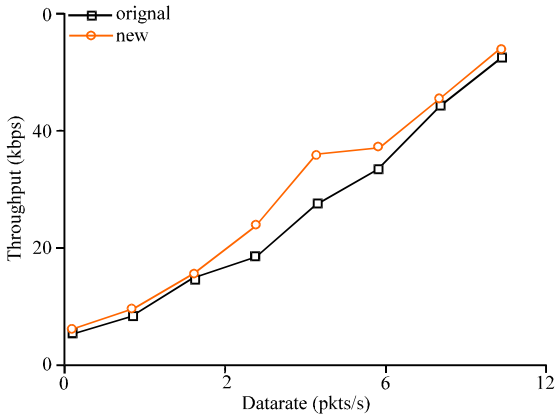

Fig. 4. Network throughput simulation result

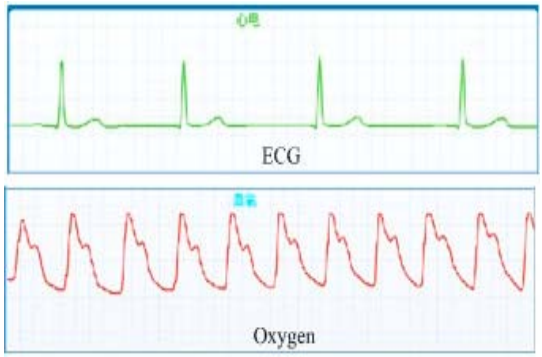

Fig. 5: Electrocardiogram and oxygen figure

Fig. 6: Blood pressure history curve

Fig. 7. Cloud platform

a transmmition can be completed within a few seconds, almost no delay.

As shown in Fig. 6, all monitoring data is ecorded, storaged, analyzed, excavated on this cloud platform. This system can contribute to detection and prevention of early disease and reduction of the harm to patients sub-health groups,and improve the quality of people's life. Medical institutions can use the system for remote monitoring of the patient, in order to reduce the number of long-term hospitalization of patients and cut down medical costs, therefore alleviate the medical resources. Fig.7 portrays the cloud platform for healthcare, which are not provided in the traditional settings.This platform not only settled the thorny issues of data ownership, possession, backup and retrieval, but also offered significant benefits to the healthcare sector. Doctor's clinics, hospitals and health clinics require quick access to computing and large storage facilities.

CONCLUTION

In this study, we proposed a adaptive binary backoff algorithm based on the CSMA/CA and which is implemented in the internet of things health care cloud systems. The algorithm can improve the performance of the throughput of this kind of BSN with high real-time needs. The effectiveness of the algorithm is verified by the simulation results. The adoption and implementation in real systems also show the usefulness of the algorithm. This system improved the standard of living for elder who require continuous monitoring of vital signs. However, wireless transmission of sensitive patient data presents some obvious security concerns. In our future work, we plan to study intrusion detection issue in order to minimize security risks.

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