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Transmission of medical messages of patient using control signal of cellular network

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ABSTRACT

The healthcare system needs to track and monitor patients' status and information. One of the most important requirements is that the patient is able to access the service anywhere at any time. Systems are being developed using the Internet to monitor patients' status, and in some areas, especially rural areas and motorways, the Internet may not be available, even though the mobile network is available. In some cases, the network might be overloaded, so the patient information cannot be delivered to the hospital or medical centre. We propose a new method that uses the spare extension of the random access channel (RACH), which is carried by physical random access channel (PRACH) to send the patient information to the medical centre. We present the mathematical model of the channel and compare the results with another system from 3GPP to evaluate the results. The results show that the proposed method needs less time to transmit the patient's information.

1. Introduction

The World Health Organization (WHO) has given priority to e-Health systems since 2005. e-Health is any technology that uses secure information and communication to support any field related to health, like health monitoring and surveillance, health-care services, and health education (W.H. Organization, 2016).

One of the most important requirements for healthcare is that people can access and be provided with healthcare services anytime and anywhere. The growth of the mobile device has led to various mobile applications for healthcare services that may fulfil this requirement, like Emergency Medical Services (EMS) and patient tracking and monitoring (Arunachalan et al., 2007). One of the major challenges is to provide healthcare services to the patients at all times (Ren et al., 2010; Gallego et al., 2005). That means the e-healthcare systems must secure a connection and communication line between the patient and the healthcare centre. Most of the applications and systems used in the healthcare services use the Internet to send the patient monitoring information to the hospital (Arunachalan et al., 2007; Gallego et al., 2005; Misbahuddin et al., 2012; Tian et al., 2009; Chaklader et al., 2014; Prakoso et al., 2016; Salman et al., 2014; Miah et al., 2017). whilst other applications use alternative methods to send the information to the hospital, such as data over voice (Werner et al., 2009).

The communication technologies try to minimize the technological gap between the rural and the urban areas (Miah et al., 2017; Traore et al., 2016), however in many cases, the patient may be in a rural area that has no Internet connection or in an area where the network is overloaded. In this instance, the patient information cannot be sent to the hospital or to the medical centre.

When the Internet channel of the mobile network is used to send user information to the service provider, the mobile operator

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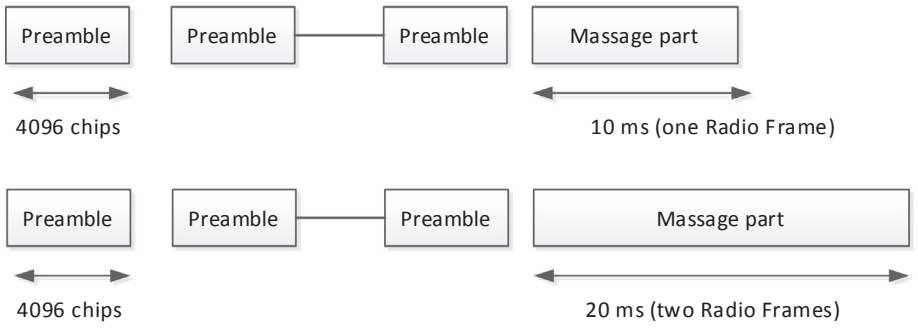

Fig. 1. Structure of the RACH.

receives the information and then forwards it to the service provider. To establish a connection between the user and the mobile operator network the Radio Resource Control (RRC) is used, and then the data goes through another procedure in the proposed system where the RRC connection uses the patient information sent along with the other control information to the mobile core network. The main proposal being made in this paper is that the patient information could be sent during the RRC connection procedure using the control channels instead of the normal channels or the Internet. This means that even if the network is overloaded or there is no Internet connection, the information could be delivered to the hospital.

We propose a solution to send the patient information or messages to the medical service centre by using the spare extension of the random access channel (RACH) of the mobile network, carried by the physical random access channel (PRACH).

PRACH is used to carry the RACH, which usually has control information. The RACH can be divided into a preamble part and a message part, as seen in Fig. 1 (3GPP_TS25.211, 2017). The length of each preamble is 4096 chips' and has 256 signatures of 16 chips'.

The structure of the random-access message part radio frame can be seen in Fig. 2, and the radio frame takes 10 ms or 20 ms in time, depending on the number of a radio frame. Each 10 ms message part radio frame is split into 15 slots.

Each slot has a length of 2560 chips and two parts: a control part that carries control information from the upper layer, and a data part where the RACH is mapped (3GPP_TS25.211, 2017).

The data part consists of 10 * 2k bits, where k = 0, 1, 2, 3. This is changeable according to the spreading factors, which are 256, 128, 64 and 32 for the RACH for the message data part. The radio frame message part usually has 10 ms message parts, while a 20 ms message part consists of two 10 ms message part radio frames. Table 1 shows the characteristics of RACH for different slot formats (3GPP_TS25.435, 2017).

The RACH channel is used to establish a connection in the Radio Resource Control (RRC) protocol, which is used in UMTS on the air interface between the UE and Node B (3GPP_TS25.331, 2017). RRC is responsible for the control signalling that includes functions like radio bearer establishment, connection establishment and connection release, broadcast of system information, reconfiguration and release, paging notification and release, connection mobility procedures (3GPP_TS25.331, 2017).

The user (UE) sends an initial signal to set-up an RRC connection; this signal is RRC Connection Request message, which is carried by CCCH using the RACH.

This paper is organised as follows: Section 2 presents selected similar research work related to emergency and health services, and Section 3 demonstrates the proposed design and solution to improve the transmission between patient and the hospital, while Section 4 shows the mathematical model of the uplink channel, and Section 5 shows system validation by comparing the mathematical model with the simulation result. Then, Section 6 shows the comparison between the results of the proposed system with the result of the 3GPP standard system for system evaluation, and finally the conclusion is presented in the last Section 7.

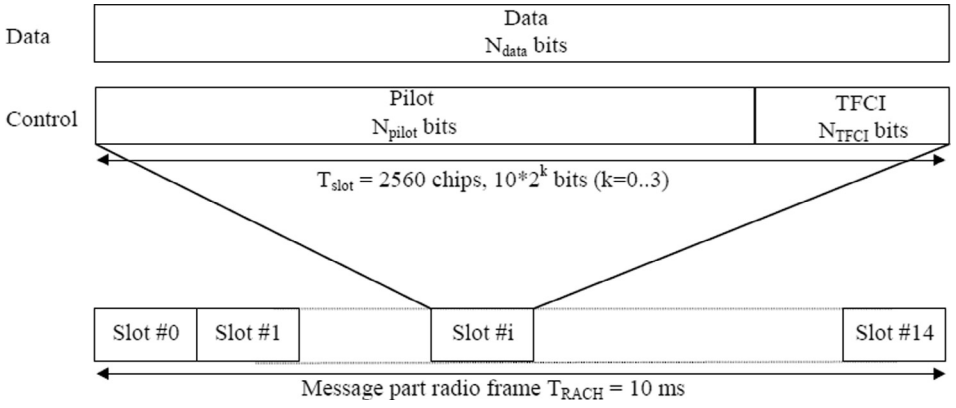

Fig. 2. Frame structure for RACH.