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Fast N-screen DRP Reservation for Multi-Hop Wireless U-health Systems

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Abstract. A hierarchical system of wireless USB (WUSB) over wireless body area networks (WBAN) is adopted for wearable health-monitoring systems (WHMS). It is executed on the basis of WUSB over WBAN protocol at each wearable sensor node comprising the WHMS. Basically, a single WHMS operates based on WUSB over WBAN protocol. And the multiple WHMSs operate based on the WiMedia D-MAC protocol and dual-role device (DRD) function. In this paper, a multi-hop N-screen traffic mechanism is proposed for WHMS networks. In a hospital, N-screen applications must be required by using WHMS networks. The multi-hop N-screen traffic mechanism is composed of a coordinated resource allocation and an N-screen multi-hop DRP Information Element. In simulation results, efficiency of the multi-hop N-screen traffic mechanism is proven through multi-hop link establishment success rate and delay performances at a WHMS network service scenario.

Keywords: Bio-informatics, Body Sensor Networks, IEEE 802.15.6, N-screen, U-health services.

1 Introduction

Wearable health-monitoring systems (WHMS) have drawn a lot of attention from the research community and the industry during the last decade as it is pointed out by the numerous and yearly increasing corresponding research and development efforts [1]. To address this demand, a variety of system prototypes and commercial products have been produced in the course of recent years, which aim at providing real-time feedback information about one's health condition, either to the user himself, to a medical center, or straight to a supervising professional physician, while being able to alert the individual in case of possible imminent health-threatening conditions. In addition to that, WHMS constitute a new means to address the issues of managing and monitoring chronic diseases, elderly people, postoperative rehabilitation patients, and persons with special abilities [1, 2].

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N-screen means multi-screen is an emerging one source multiple use (OSMU) technology and demand of future to support multimedia multicasting, content sharing, content mobility, media scalability, media synchronization, and seamless mobility. The initial N-Screen service has begun from three-screen services of AT&T in 2007 and has meant the service that enables the users to utilize content with various ways by connecting TV, PC, and mobile phone the most commonly used by users. In this paper, a hierarchical system of WUSB over WBAN is adopted for wearable health-monitoring systems (WHMS) [3]. It is executed on the basis of WUSB over WBAN protocol at each wearable sensor node comprising the WHMS. Basically, a single WHMS operates based on WUSB over WBAN protocol. And the multiple WHMSs operate based on the WiMedia D-MAC protocol and dual-role device (DRD) function, combined with RFID systems as shown in Fig. 1 and 2 [4-6].

In a hospital, the OSMU (One Source Multi Use) P2P N-screen applications must be required by using WHMS networks. But, data traffics must be delivered to multi-hop points in multiple rooms [7-10]. In this paper, we propose a multi-hop N-screen traffic mechanism, by using a coordinated resource allocation and an N-screen multi-hop DRP Information Element, in WHMS networks. The proposed scheme can improve multi-hop throughput performance of WHMS Vital Video (WVV) applications. Also, proposed scheme can reduce WVV link establishment time since it minimizes the multi-hop WVV data delivery process.

2 Multi-hop traffic mechanism for WHMS N-screen services

In this paper, we propose N-screen multi-hop MSCDRP (Multi-Stage Coordinated DRP) reservation scheme to minimize the end-to-end delay in WHMS network. MSCDRP IE includes addresses of all devices on path between WHMS source device and WHMS destination device. Also, MSCDRP IE includes Element ID that describes the information element for multi-stage coordinated communication, and includes length field, control field, and many device address fields on its multi-hop path.

Figure 3 shows reservation negotiation process for proposed WHMS MSCDRP scheme. The purpose of the negotiation process is to reserve MASs for data transmission between the two devices. In this process, two different information elements, i.e. DRP IE defined in the current WiMedia standard and the proposed MSCDRP IE may be used. Reservation owner collects DRP IE validity check values of one or more devices to include into own MSCDRP IE. The device that receives the DRP validity check request responds to reservation owner using its own MSCDRP IE whether to reserve medium access slots (MAS) or not.

WHMS subdivides the superframe into 16 equal pieces, called allocation zones. The nominal duration of an allocation zone is 4096 μs. Each allocation zone is identified by its index, a number between 0 and 15, inclusive. Allocation zone zero, the beacon zone, is reserved for the beacon period. Each allocation zone is subdivided into 16 medium access slots (MAS). A MAS is the smallest quantum of channel time allocation, 256 μs. Each MAS is identified by its index, a number between 0 and 255, inclusive, which represents the position of the MAS within the superframe. An allocation zone consists of MAS_n through MAS_{n+15}, inclusive, where n is equal to 16 times the allocation zone's index. Within a superframe, MAS from different allocation zones are organized into coordinated MAS sets from [5].

Each isozone is identified by its iso-index, which range from 0 through 3. The MASs within an isozone are distributed evenly across the superframe. MAS located in the same row and an adjacent allocation zone within the same isozone are separated from each other by the isozone's native service interval. This isozone structure has the properties that are desirable for satisfying a range of service interval requirements while conditionally optimizing a WHMS reservation's bandwidth and power efficiency

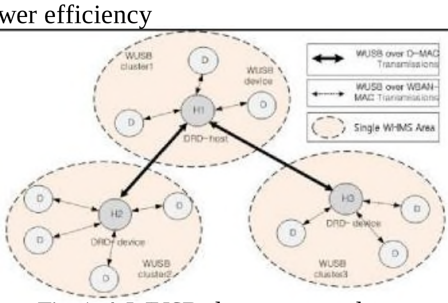

Fig. 1. A WUSB cluster tree topology for multiple WHMS networks

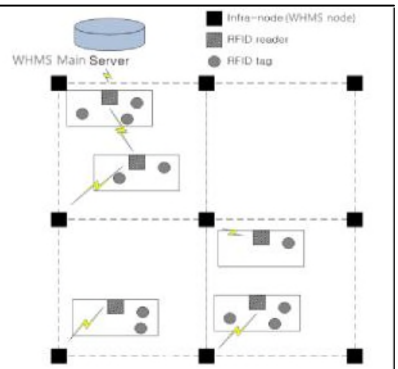

Fig. 2. A RFID-based WHMS in multi-rooms of a hospital

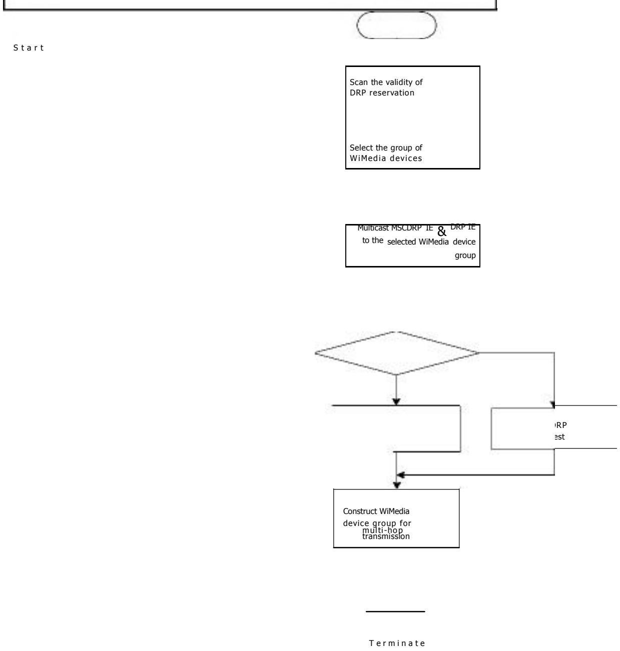

Fig. 3. N-screen multi-hop MSCDRP reservation process

3 Experiment and Conclusion

When the network is heavily loaded (e.g., over 80 percent), our approach and the legacy WHMS system, irrespective of the number of trials, both show low success ratios. This is mainly due to the limited resource in the saturated WHMS network. In fact, we could not obtain any meaningful results when the network load is over 80 percent, because the number of multi-hop WVV links established was very small. Compared to the legacy WHMS system, the proposed multi-hop N-screen traffic mechanism shows much higher success rate. In fact, our scheme shows the higher success rate and the smaller link delay under most WHMS network loads. This result clearly demonstrates the superiority of our scheme for WHMS networks with better multi-hop N-screen WVV link connectivity.

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