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Message Processing at Integrated PHD Gateways for Servicing Various PHDs

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Abstract

Due to the wide variety of PHDs, the tasks related to PHD management have become more complicated than ever. In this paper, we propose a message processing scheme at an integrated PHD gateway that serves various PHDs. On receiving the ISO/IEEE-based health messages generated by PHDs, the PHD gateway module in the gateway puts the messages together to generate an integrated message and send it to the integrated PHD management server. ISO/IEEE 11073 protocol has to be extended when there are multiple and diverse PHDs to be managed, because the protocol does not specify how to process the diverse health messages generated by various PHDs. Therefore, in this paper, attribute IDs are assigned hierarchically to identify a specific attribute generated by a specific PHD and passed through a specific gateway. When the DM gateway module in the gateway receives an integrated OMA DM-based PHD management message from the server, the gateway separates its various parts to generate individual messages and send them to the related PHDs. For this purpose, OMA DM protocol is extended and the DM trees are managed hierarchically. Some examples of message processing (integration and separation) at the gateway are shown.

Keywords: *Personal health device, Message processing, Message integration, Message separation, various PHDs, integrated PHD gateway*

1. Introduction

Due to the wide variety of PHDs (Personal Health Devices), the tasks related to PHD management have become more complicated than ever. There are various PHDs being used in the ubiquitous computing environment [1-5]. Some of the typical PHDs include oximeters, blood pressure monitors, blood glucose meters, activity monitors, SpO2 Monitors, and medication dispensers [6-14].

In this paper, we propose a message processing scheme for an integrated PHD gateway in an integrated PHD management system that serves various PHDs. On receiving the ISO/IEEE-based health messages [1-6] generated by PHDs, the integrated PHD gateway performs some integration work to send an integrated message to the integrated PHD management server. Also, when the integrated PHD gateway receives the OMA DM-based PHD management messages [15, 16] from the server, the gateway performs some separation work to send the messages to the related PHDs separately.

The remainder of this paper is organized as follows. Section 2 discusses the related studies and Section 3 provides an overview of the integrated PHD management system to which the proposed integrated PHD gateway belongs. Section 4 describes the proposed message

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processing scheme at an integrated PHD gateway, and Section 5 draws conclusions and discusses some future directions for research.

2. Related Studies

A study on an integrated gateway for various PHDs was conducted in [17]. This gateway receives measurements from various PHDs and conveys them to a remote monitoring server. It provides two kinds of transmission modes: immediate transmission and integrated transmission. The former mode operates if a measurement exceeds a predetermined threshold or in the event of an emergency. In the latter mode, the gateway retains the measurements instead of forwarding them. When the reporting time comes, the gateway extracts all the stored measurements, integrates them into one message, and transmits the integrated message to the monitoring server.

There are some differences between the gateway study proposed in this paper and the gateway study in [17]. In [17], there is only one gateway in the system, and the ISO/IEEE health attribute has only one handle. In this paper, it is assumed that there are many gateways, and therefore three attribute handles are assigned hierarchically to identify a specific attribute generated by a specific PHD and passed through a specific gateway. In addition, the study in [17] considers ISO/IEEE health messages only, while the study in this paper deals with OMA DM management messages as well as ISO/IEEE health messages.

3. System Overview

Figure 1 shows the structure of the integrated PHD management system proposed in this paper. The integrated PHD management system consists of PHDs, integrated PHD gateways and an integrated PHD management server. A large number of various PHDs can be managed remotely by the system.

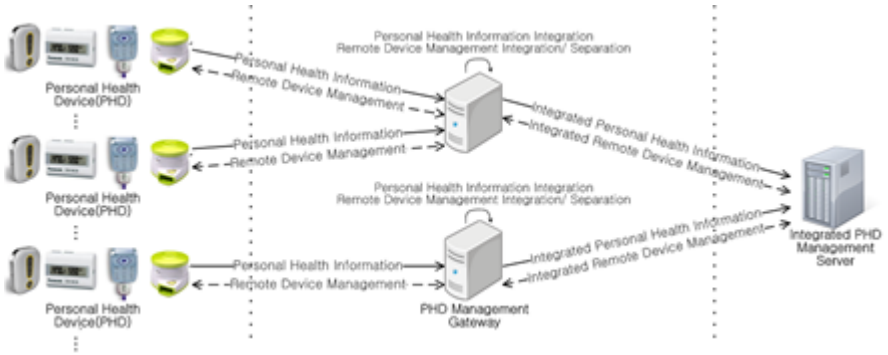

Figure 1. Structure of an integrated PHD management system

Located between PHDs and the integrated PHD management server, integrated PHD gateways transform the ISO/IEEE 11073 based messages into OMA DM based messages, and vice versa. The ISO/IEEE 11073 communication protocol is used to transmit health messages measured by a PHD to the integrated PHD management server via the related integrated PHD gateway. The OMA DM communication protocol is used to transmit device management commands issued by the integrated PHD management server to a PHD via the related integrated PHD gateway. Since PHDs use diverse health message formats, a gateway puts the messages sent from PHDs together to form an integrated message and transmit the message to the PHD management server. Also, when a gateway receives an integrated PHD management

message from the server, the gateway separates out the integrated message to get diverse messages for various PHDs.

4. Message Processing of the Integrated PHD Gateway

Figure 2 shows the structure of the integrated PHD gateway proposed in the earlier study [18]. The gateway consists of a PHD gateway module and DM gateway module. The role of the PHD gateway module in the PHD management gateway is to receive the diverse health messages from various PHDs, integrate the messages into one integrated message, and send it to the integrated PHD management server. Also, on receiving an integrated PHD management message from the server, which may contain separate PHD management messages for each PHD, the DM module in the gateway breaks the message into several PHD management messages to transmit them to the related PHDs.

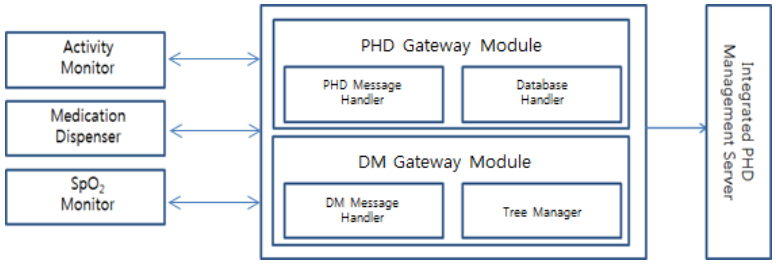

Figure 2. Structure of the integrated PHD gateway

4.1. Integration of ISO/IEEE messages by the gateway

ISO/IEEE 11073 protocol has to be extended when there are many and diverse PHDs to be managed, because the protocol does not specify how to process the diverse health messages generated by various PHDs. Therefore, in this paper, attribute IDs are assigned hierarchically to identify a specific attribute generated by a specific PHD and passed through a specific gateway, as shown in Figure 3. An attribute generated by a PHD has a unique 2-tuple ID (Local Handle, Attribute). At a gateway, the attribute is identified by a 4-tuple ID (PHD ID, Region Handle, Local handle, Attribute). Finally, the attribute is stored at the server with a 6-tuple ID (Gateway ID, PHD ID, Global Handle, Region Handle, Local Handle, Attribute).

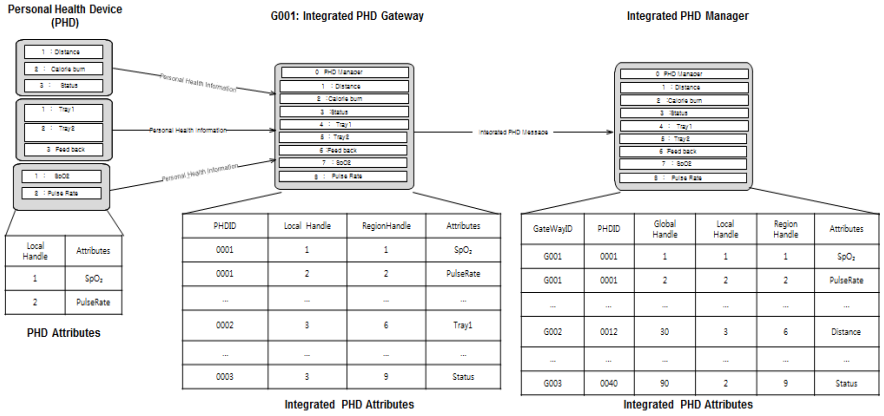

Figure 3. Integration of ISO/IEEE attributes

Figure 4 shows an example of ISO/IEEE health message generation at PHDs. In this example, two PHDs (Pulse oximeter and Medication dispenser) generate the ISO/IEEE health messages (right-hand side) based on the health attribute (left-hand side) measured by the PHDs to send them to the gateway. Upon receiving two ISO/IEEE health messages generated and sent by the PHDs, the gateway integrates the messages into one integrated health message, which is sent to the server. Figure 5 shows an example of an integration of ISO/IEEE health messages at a gateway.

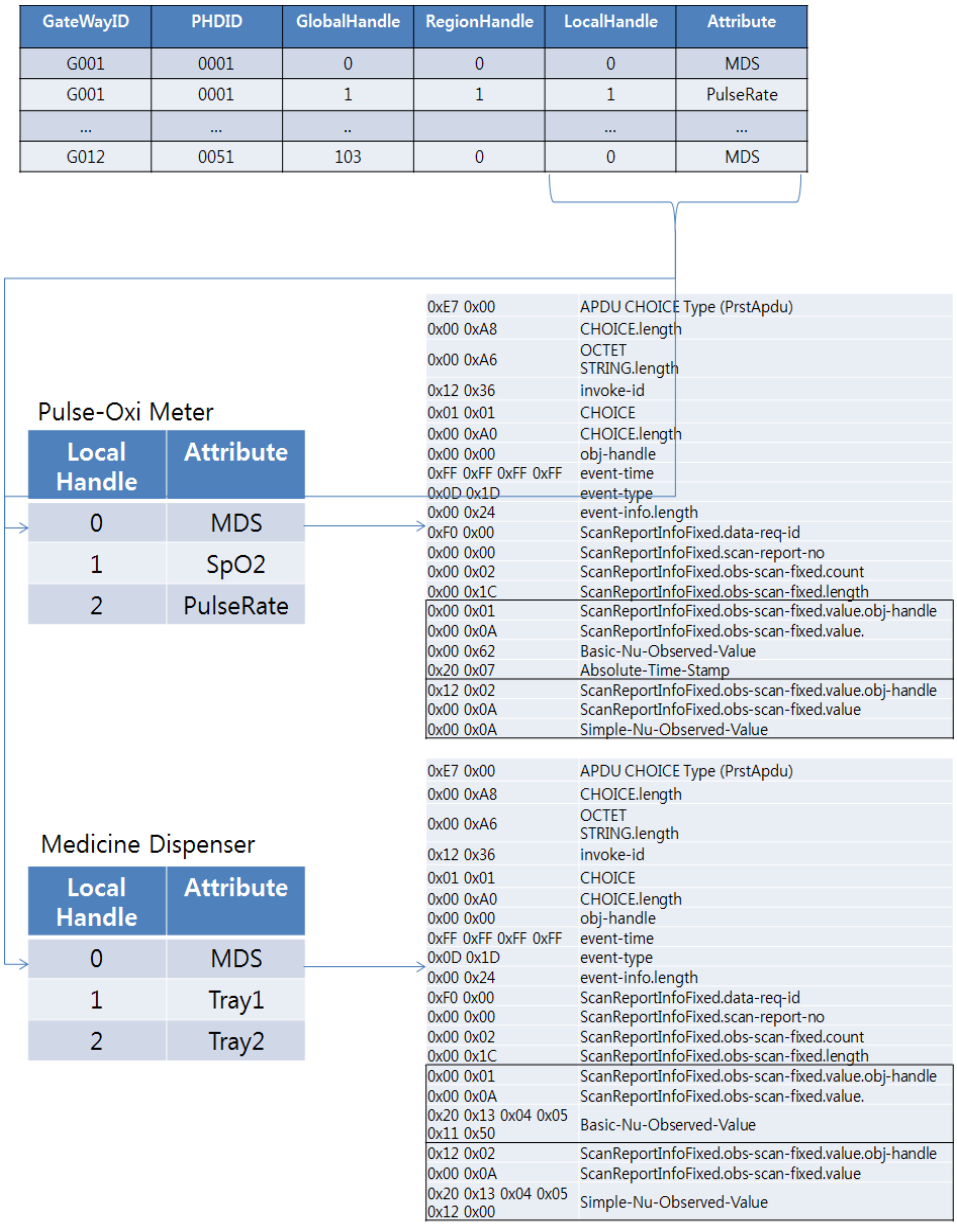

Figure 4. ISO/IEEE health messages generated by PHDs

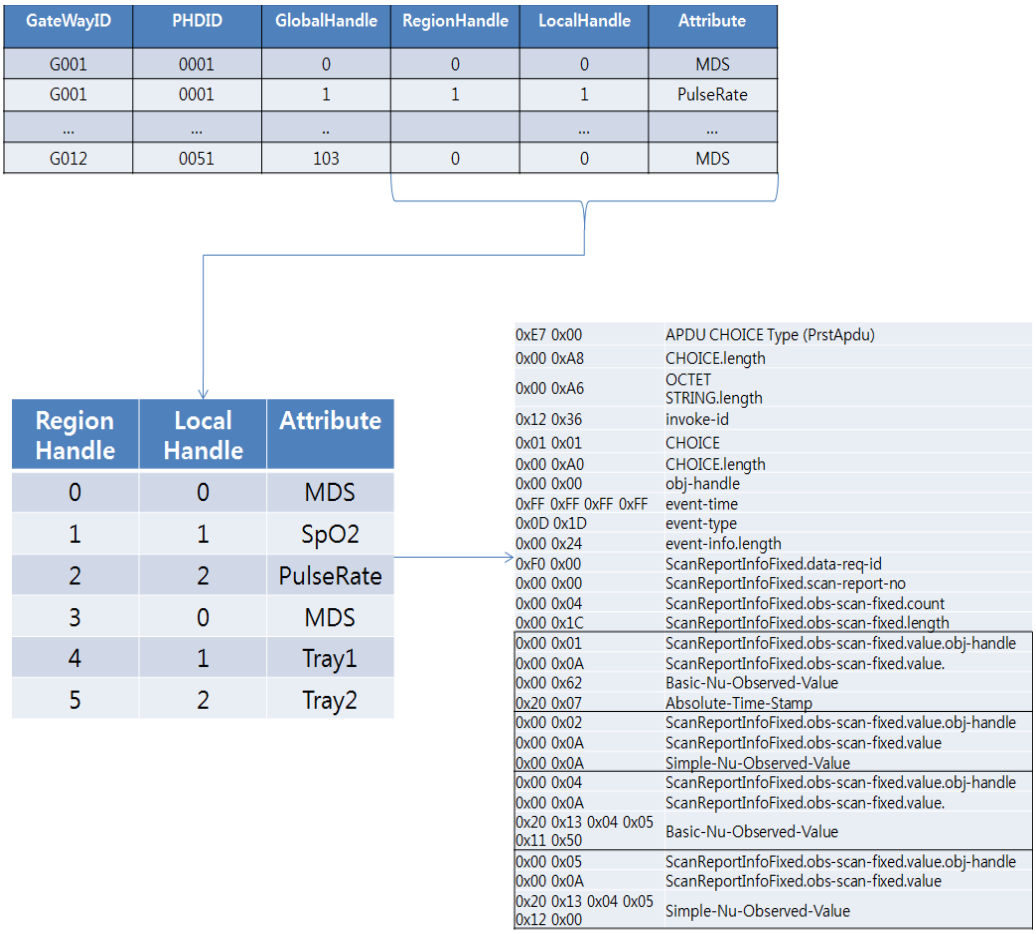

Figure 5. Integrated ISO/IEEE messages by the PHD gateway (example)

4.2. Separation of OMA DM messages by the gateway

Figure 6 shows DM trees for each component in the system that was proposed in the earlier study [18]. The DM agent module in a PHD maintains the smallest DM tree (in the meshed area) to keep the information on the PHD attributes only, while the DM gateway module in a PHD management gateway maintains the DM trees (in the darkest area) which covers all of the DM trees for the related PHDs. Finally, the integrated DM module in the integrated PHD management server keeps the DM tree of the entire system (*i.e.*, covers all of the gateways in the system).

Figure 7 shows an example of OMA DM management message separation. The server generates an integrated OMA DM management message (right-hand side) to send it to a gateway. The integrated management message contains two management messages for two PHDs (P001 and P002). Upon receiving the integrated management message from the server, the gateway separates the message into two messages to send them to P001 and P002 separately.

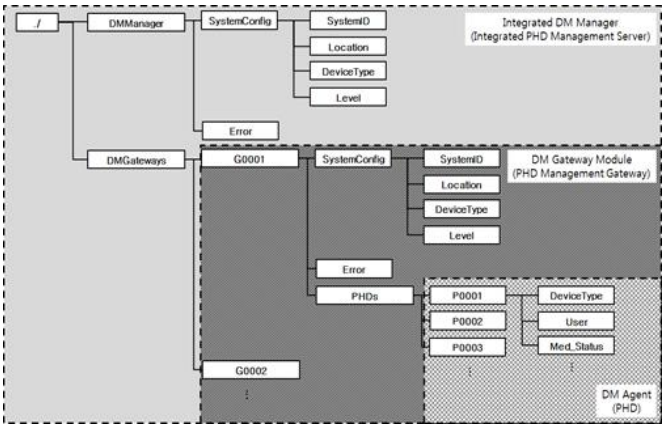

Figure 6. DM trees stored in the system

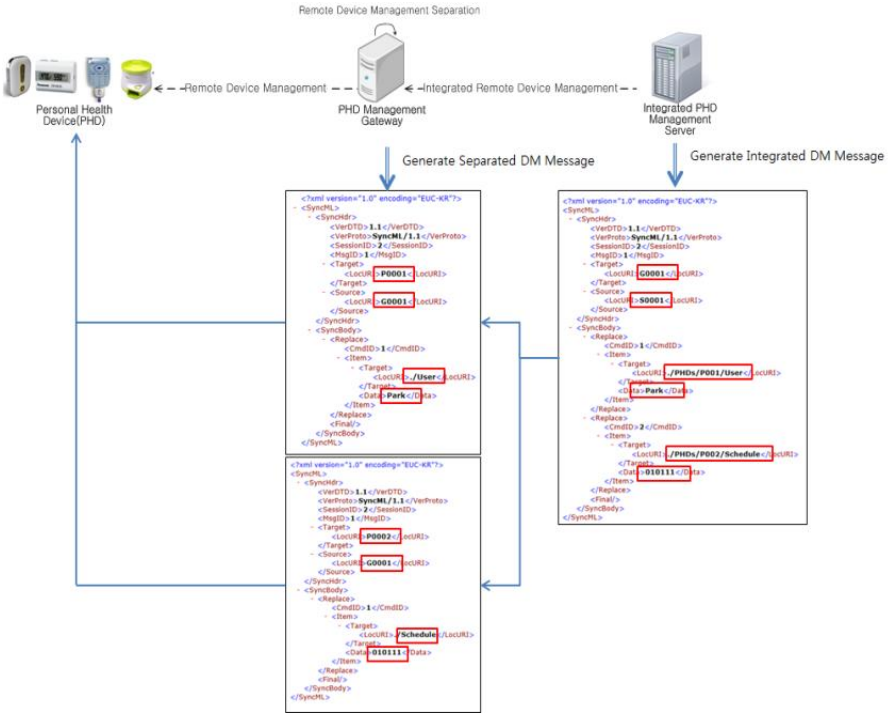

Figure 7. Separation of OMA DM messages by the gateway

5. Conclusion and Future Research

In this paper, a message processing scheme of an integrated PHD gateway located between various PHDs and the integrated PHD management server is proposed. Some examples are used to explain how various messages from diverse PHDs are processed in the gateway. On receiving the ISO/IEEE-based health messages generated by PHDs, the PHD gateway module in the gateway puts the messages together to generate an integrated message and send it to the integrated PHD management server. Because it is assumed that there are many and diverse PHDs and many gateways in the system, in order to identify a specific attribute in an integrated message, the ISO/IEEE 11073 protocol is extended and attribute IDs are assigned hierarchically. Also, when the DM gateway module in the gateway receives an integrated

OMA DM-based PHD management message from the server, the gateway separates it out to generate individual messages and send them to the related PHDs separately. For this purpose, OMA DM protocol is extended to manage the DM trees hierarchically. Some examples of message processing (integration and separation) at the gateway are shown.

Currently, the message processing scheme of the gateway proposed in this paper is being constructed. In the future, more efficient internal structure and message processing methods will be studied.

Acknowledgements

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