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Manual nurse messaging with patient information using a mobile whiteboard system

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ABSTRACT

Nurses are the backbone of hospitals. They are mobile all the time and they can be anywhere in the hospital. To improve the communication between nurses, publicly visible displays such as manual whiteboards are heavily used in the nursing units. However, HIPAA limits the information displayed in these public displays. In this paper, a software solution called whiteboard which is HIPAA compliant is developed to replace these manual public displays. The software whiteboard is visible only to the nurses and integrates the staff assignments from the nurse call system, the patient and the bed information from the ADT (admission-discharge-transfer) interface, and the staff location information from the location server. Nurses can use this information to improve the staff communication, do the planning, and see the bed occupancy status in their nursing units.

1. Introduction

Nurse call systems are stand alone systems where the patient pushes a button and a series of light indicators are activated above the doorways to indicate that the nurse's presence required in the room. Many advances have happened in both hardware and software to improve the most important part of the nurse call system, that is, the communication. However, there is still no technology to replace the face to face communication between the patient and the nurse, yet nurses need advanced technologies to answer the patients' requests as quickly as possible wherever they might be in the hospital. Nowadays, most hospitals use manual whiteboards to create an overview of the patients in their nursing units. These whiteboards provide access to patient information and help caregivers to do co-ordination and planning [1,2]. Furthermore, these static whiteboards are not connected to other nursing units. HIPAA rules also limit what might be displayed on these boards since they are publicly visible [3,4]. Some hospitals now use electronic whiteboards instead of manual whiteboards. Typically these whiteboards are smaller than the manual ones and therefore, they can be placed in areas where only nurses can have access to the patient information. However, these electronic whiteboards are deficient in the sense that nurses cannot construct and send a message out of those electronic whiteboards. The solution provided in this paper is a real time software application called 'mobile whiteboard' which allows the nurses to construct and route messages compromising information obtained from the whiteboard. When other staff members get these messages, they may provide immediate and efficient services to the patients. For example, the whiteboard gets the staff assignments from the nurse call system, so when the nurse looks at the whiteboard application, he\she can easily know which nurse is responsible, say, for the patient in Room# 1021. So, the operator instantaneously sends a message to the responsible nurse alerting

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him/her of patient needs. And also, the operator can easily see that if there is an active call still waiting unanswered in Room# 1021. Because of the information provided by the ADT (admission-discharge-transfer) interface system, the operator can easily decide if the nursing unit is out of beds or not within the whiteboard application.

The next section presents the whiteboard design; Section 3 presents the whiteboard application example and the Section 4 talks about the conclusion and the future work.

2. Whiteboard design

Fig. 1 shows a nurse call system with the ADT interface, the location system, the database server and the whiteboard applications. Information for the whiteboard application can be obtained from the ADT interface, the nurse call system, the location system, and by manual intervention. Nurses and patients carry the RFID tags and the antenna on the tag picks up the electro-magnetic energy beamed at it from a reader device and enables the badge to transmit its unique ID to the reader device which is located in the patient rooms, in the hallways etc., allowing the nurse, or the patient to be remotely identified. The reader converts the radio waves coming back from the badge into digital information that can then be transmitted to the location server for processing [5–9]. The location server writes this location data into the database server.

The location system uses RFID (radio frequency identification) technology. It is integrated into the nurse call system to establish, maintain, and monitor the location information of staff, patient, and equipment, so that this information can be displayed within the whiteboard application. The communication must be timely enough to follow staff, patient or equipment as they move from room to room without missing a location [5,6]. Furthermore, these location change details are saved into the database server to show how well the system handles the requests from the patients.

The ADT interface employs an emerging standard of communications between hospital computer systems for maintaining the hospital bed occupancy. The whiteboard application shows this bed occupancy status to the caregivers. The standard is called Health Level 7 (HL7) [10]. The HL7 standard was established by an organization of hospital computer system vendors. The organization published a document that fully describes the requirements of the standard. The HL7 standard has changed since its inception. However, the organization has been careful to maintain backward compatibility in succeeding versions of the standard.

In Fig. 1, there are N whiteboard applications in the nursing unit. The nurses can get to the whiteboard application on any PC as long as this PC is on the hospital LAN network. These whiteboard applications are essential to the nurses while they provide care to the patients since these applications improve the collaborative work between nurses. When a nurse enters a note about a patient manually in one of the whiteboard application, all the other whiteboard applications display the same note almost instantaneously for the same patient. Moreover, since the whiteboard PCs are only visible to the nurses, they are not publicly available like the manual whiteboards.

Table 1 – Logging levels.

Level	Logging states and run-time exceptions
Level-0	Events are heartbeat messages that are sent to target at regular intervals.
Level-1	Events consist of non-critical communication messages such as warning messages.
Level-2	Events represent recoverable errors, which mean the system recovers from errors without user involvement.
Level-3	Events hold critical events, which require user attention.
Level-4	Events contain link failures and recoveries.

Core functions, such as the Client Control DLL and the Logging Control DLL are implemented as components for the whiteboard software application. The benefits of implementing these components are significant [11,12]. Some of them are mentioned below for this study:

- This has increased the product reliability because the code within these components has already been subject to engineering tests.
- It has helped to decrease time to release for the whiteboard application by reducing the duration of design, code and testing efforts [13,14].

Logging Control DLL component simplifies the recording of messaging into the database server between whiteboard applications and major events within the Whiteboard application for debugging and diagnostic purposes [15,16]. Furthermore, the Client Control DLL simplifies communication with the location server for communication with a non-visual control. The next sections elaborate on these components.

2.1. *Logging control DLL*

The best way to assess software robustness and performance is to employ a logging mechanism where states and errors of software are traced. A log entry in this logging system is simply a formatted message that contains important information that can be used during analysis. A well-formed log entry includes the following information:

Logging Level: Logging is broken into five levels [13,15] with the most critical events logged at Level-4, and fewer critical events logged at levels 3, 2, 1 and 0. Table 1 contains a list of logging levels for logging run-time exceptions.

Statistic Name: Each logged message at each logging level is recorded with a statistic name. The names are used in generation of statistics for each application, for example, FAIL and RECOVER are the statistic names for level-4 events. These statistics indicate when the application fails and recovers successfully.

Message: The message section of the log entry holds the actual message. This message is either the error or the state of the application. These verbal messages help developers to debug applications in debug mode and to investigate performance in release mode.

Based on the description of the behavior of a log entry, the question now arises of how to capture the actual behavior of a software application, i.e., on how to specify the trace