Process model verifier for integrated medical healthcare systems using business process management system

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Abstract—**The integration of disparate medical healthcare systems such as hospital information system (HIS), radiology information system (RIS), and picture achieving and communication system (PACS) with the business process management system (BPMS) have garnered a considerable amount of attention for amalgamation with systems in external medical institutions. However, no effective process verification method exists in BPMS for medical healthcare systems, although considerable efforts have been expended on verification techniques in BPM research fields. In this paper, we propose a process model verifier that covers control-flow, data-flow, and business compliance rules for integrating medical healthcare systems using BPMS.**

Keywords—Business Process; Process Verification; Medical Healthcare Systems

I. INTRODUCTION

Increasing demands on computerized medical image records and automated patient data exchange processes have resulted in integrated medical healthcare systems, such as HIS, RIS, and PACS, being established via distributed computing system techniques at hospitals with standard message protocols, namely, digital imaging and communications in medicine (DICOM) and health level seven (HL7). Such integrated systems have facilitated faster access to patients image and medical reports and provided improved image views for more accurate diagnosis by radiologists [1]. However, because of the technical limitations of distributed computing systems, these integrated medical healthcare systems only provide standalone processes, even though they are related with inter-organizational medical radiology services.

Collaboration and integration of medical healthcare systems of hospitals and medical institutions has also garnered significant amounts of interest in current medical industry research fields as it is felt that this could eliminate the possibility of duplicated testing, reduce patient wait times, and provide fast treatment to emergent patients without having to transfer them to other hospitals or external medical institutions. Consequently, Integrating the Healthcare Enterprise (IHE), a non-profit organization tasked with improving the way computer systems in healthcare share information, provides a web-service-related technical framework [2]. R.Anzbock [1] has also proposed applying BPM technologies to facilitate the integration and communication of medical healthcare systems of hospitals and medical institutions to facilitate the delivery of medical images that have been examined and patient information data by leveraging web-service techniques such as

platform-independence, lightweight service descriptions and invocations, and automated web-service compositions. Figure 1 shows a generic medical healthcare systems framework that uses a web-service-based business process management system (BPMS).
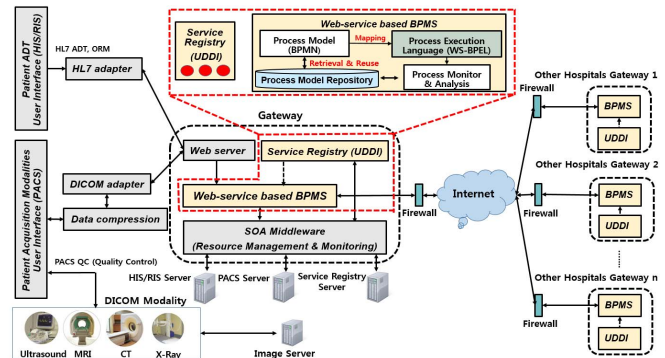

Figure. 1. Generic medical healthcare systems using web-service BPMS

BPMS is a model-based process-aware system [1]. This means that BPMS uses model-based development for service implementations by defined process models. This process model is automatically converted to WS-BPEL, which is web-services executable language [1]. Therefore, the process model that is designed should be a complete and consistent process model, and should not contain any process anomalies. However, even though the process model is important, current research into verification techniques primarily focus on the control-flow perspective. This is associated with verifying the flow of the control structure, which comprises selection, mergence, and iteration structures on process models by "reachability" and "liveness" of tokens for structural correctness [3]. However, these control-flow perspectives verification methods do not consider data interactions and the compliance of sets of business rules in process models. In the medical radiology information process, in particular, HL7 and DICOM message data are strongly related to the execution of tasks to be enabled or disabled at the data level. However, if some HL7 or DICOM message data are missing or lost in process execution, critical process anomalies that result in deadlock or unexpected process results could occur. Furthermore, business rules or medical guidelines are important aspects of a process model that need to be verified. Rearranged exam schedules of emergent patients or treatment order modalities by doctor's order should be reflected in the process model.