Adaptive Medical Workflow Using BPEL Process and Ontological Knowledge Base

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ABSTRACT

Known as BPM-over-SOA, BPMS (Business Process Management System) is becoming the runtime governance of SOA (Service-Oriented Architecture) applications with the widespread of Web services and the emergence of SOA framework. It provides tools and methodologies to compose Web services that can be executed as business processes and monitored by BPM consoles. Ontologies are a formal declarative knowledge representation model. It provides a foundation upon which machine understandable knowledge can be obtained, and as a result, it makes machine intelligence possible. Health care systems can adopt these technologies to make themselves ubiquitous, adaptive, and intelligent, and then serve patients better. This paper presents a BPM-over-SOA workflow management system that allows users, from physicians to the administrative assistants, to manage, even create context-aware new medical workflows and execute them on-the-fly with the support from an ontological knowledge base.

Keywords

BPEL workflow, Web services, Ontology

1. INTRODUCTION

From a process-centric viewpoint, a workflow is a composed process of a set of activity, each of which is fulfilled by performing a service. Herein, we use the term process and workflow interchangeably. From a SOA viewpoint, a workflow is a set of services and a specification for the control and data flow among these services to address some business needs. With the widespread of Internet and Web services, workflows are becoming ubiquitous in enterprise applications from manufacturing industry to health care industry, and SOA has become the most praised way of dealing with issues in a workflow such as interoperability, development efficiency and system scalability in enterprise application integration. BPM systems provide methodologies to governance service selection, composition, execution, and monitoring.

As a formal declarative knowledge representation model, an ontology is developed to describe our hospital process model, and serves as a knowledge base to guide users through workflow orchestration. By providing a more comprehensible and formal semantics, it helps business rules, enterprise policies, and running environment context be described to support adaptive workflow orchestration and execution. Therefore, the use of and reference to ontology help the functionalities of service to be described, advertised from a business perspective, and these functionalities can be discovered, and composed by business specialists, instead of IT professionals.

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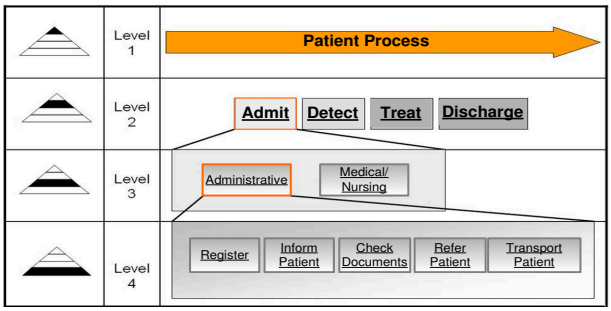

Figure 1: Administration in Healthcare Process

With an ontological knowledge base of process model, we propose an adaptive medical workflow system for hospitals. our system allows users to: (1) control the flow of processes that a patient will pass through; (2) manage the patient's medical record and personal data; (3) allow the physicians to add new processes composed of simple tasks from a medical service repository; and (4) maintain the history of the processes that a patient passed through for further diagnosis. Most existing workflow systems do not introduce ontological prior knowledge for process design or orchestration. They are not context aware and do not support dynamic process orchestration and execution. In contrast, this paper advances the state of the art by (1) bridging the gap between IT and business for hospitals; (2) modeling healthcare processes and hospital policies in an ontological knowledge base; (3) developing an intuitive Web-based system to help users to dynamically orchestrate and execute context-aware processes.

2. A HOSPITAL SCENARIO

2.1 Healthcare Process References

To build an adaptive workflow system for hospitals, it is important to build a process model by which hospitals can

take good care of their patients. The MED Global solutions group at Siemens have used a methodological approach to describe the different processes accomplished in a healthcare enterprise. From Fig.1, we can see that a patient passes through 4 main steps which are: Admit, Detect, Treat and Discharge. Each one of these can be again separated in different groups and composed of sub-processes. In order to let users deploy new processes under this process model, we developed a ontological knowledge base to describe the semantics of healthcare processes and make their content and relationships explicit for machine intelligence.

2.2 A Motivating Scenario

When a patient comes at the hospital, he should register himself in a waiting list. An administrative assistant can check the data of the patient like the insurance company, if the patient has already been in the hospital, address, etc. Having passed this step the patient will pass to the next step which is the diagnosis or detect, where a physician might do some tests like blood or X-ray. After that, the treatment phase follows and consists of treating the patient's disease by for instance applying a surgery and/or a plaster. The last step is the discharge where the patient will get out of the hospital and all the data gathered during all the processes he passed through, will be saved for history. Patient may have to have his/her treatment plan updated from time to time. This uncertainty exists because of newcome findings from test, unexpected outcome from treatment, lack of resource, and emergency. our system provides an intuitive way to users to create and execute a context-aware user-specific process for this patient. Moreover, this newly created process can be stored in our service repository for future use.

3. ADAPTIVE WORKFLOW SYSTEM FOR HOSPITALS

3.1 Ontological Knowledge Base

Ontologies provide a formal semantic knowledge representation model to capture the hierarchy information and business intelligence behind the described process hierarchy. Other constraints can also be added to the ontology. By adopting an ontological knowledge base, we separate business rules represented in knowledge base from process logic defined in a process.

In a workflow, one of the important aspect is the role of actors involved in the whole process. Since many users can interact with the system, it is essential to define roles and to have formalization of the tasks assigned to roles. In our current implementation, we only allow physicians to create new processes and deploy them. With the help of the ontology, we have achieved this step by using the Web Ontology Language (OWL) to define roles and the tasks they are assigned as prior knowledge. This ontology is also used to formalize the reference processes and constraints.

3.2 System architecture

As shown in Fig. 2, this project is composed of several web applications. First of all, there is the BPEL Server deployed on the Oracle application server for J2EE, which is the cornerstone of our system. Here we are going to explain major applications implemented and deployed in this system:

- TaskAssigner on the Tomcat server is the web service in charge of assigning tasks to different roles and checking their status.

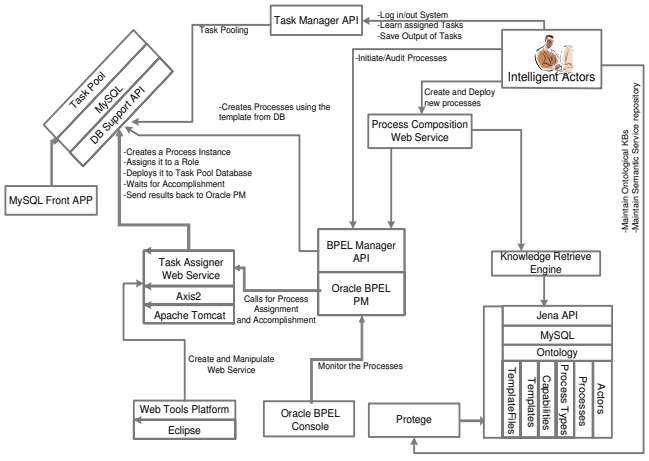

Figure 2: System Architecture

- KnowledgeRetrieveEngine is the application that uses Jena APIs to save ontologies in a rational database. It can also be used by other applications to retrieve ontologies from the database.

- ProcessComposition is the web service called when a phyisician wants to create and deploy a new composed process. The service creates all the files needed and deploy them on the Oracle BPEL Server.

3.3 Dynamic Process Orchestration

As described before, the dynamic workflow orchestration is one of the main features of our system. Our system makes adaptive workflow possible by letting healthcare specialists create new medical processes without knowing anything about IT infrastructure or BPEL code. This composer can be seen as the first accomplishment to bridge healthcare needs and IT technologies in a hospital. In addition, the composer constructs the tree of relationship between the parent process, the context in which the process has been deployed, and the new process. This allows the users to see the history of all the processes that a patient has passed through. For the sake of usability, our system allows users to save newly composed processes on the BPEL Server, and make them available for future use.

4. FUTURE WORK

This paper presents an adaptive workflow system with an ontological knowledge base. There are several possible directions for future work. First, we are exploring OWL-S semantic Web service description to elaborate the automation process selection and orchestration. Second, we will adopt a semantic rule engine to facilitate the ontological knowledge retrieve and reasoning procedure.

5. ACKNOWLEDGMENTS

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