시맨틱 헬스케어를 위한 상호정보교환 프로세스

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Towards Semantic Healthcare with Interoperable Processes

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Abstract

Due to heterogeneity in Data and Processes, healthcare systems are facing the challenge of interoperability. This heterogeneity results in different healthcare workflows of each individual organization. The compatibility of these heterogeneous workflows is possible when standards are followed. HL7 is one of the standards that is used for communicating medical data between healthcare systems. Its newer version V3 is providing semantic interoperability which is lacking in V2. The interoperability in HL7 V3 is only limited to data level and process level interoperability needs to be catered. The process level interoperability is achieved only when heterogeneous workflows are aligned. These workflows are very complex in nature due to continuous change in medical data resulting in problems related to maintenance and degree of automation. Semantic technologies plays important role in resolving the above mentioned problems. This research work is based on the integration of semantic technology in HL7 V3 standard to achieve semantic process interoperability. Web Service Modeling Framework (WSMF) is used for incorporating semantics in HL7 V3 processes and achieves seamless communication. Interaction Ontology represents the process artifacts of HL7 V3 and helps in achieving automation.

1. Introduction

Healthcare domain is facing severe issues in integration and interoperability of the systems. Researchers are trying to make the systems usable and useful by making them interoperable and integrate able for the benefits of end users, hospitals, clinicians, and other medical support staff. The broader goal of interoperability can only be achieved when standards are practiced. Health Level Seven (HL7) [1] is one of the standards that claims providing interoperability and is used for the communication of medical information across the systems.

Two commonly used variants of HL7 are HL7 V2 and V3. The paradigm shift is based on solving the intrinsic shortcomings of HL7 V2.x such as the absence of reference model [2]. HL7 V3 claims to provide semantic interoperability, which is otherwise lacking in the V2. Semantic interoperability can be seen from two perspectives semantic data interoperability and semantic process interoperability. HL7 V3 claims the support for data interoperability while semantic process interoperability is still a grey area [3].

To make HL7 system semantically interoperable, there is a need to make use of the specifications of the HL7 processes and also the role of messages in it. Process artifacts are the components that are responsible for handling the behavioral aspects of HL7 processes. These include application roles, interactions, trigger events and message types [4]. WSMF [5] is a framework targeting at process handling and automation based on semantic based knowledge. It is based on Semantic Service Oriented Architecture (SSOA) that is composed of three sub architectures Web Service Modeling Ontology (WSMO) [6], Web Service Modeling Language (WSML) [7], and Web Service Execution Environment (WSMX) [8]. WSMO is the conceptual model that is made up of four entities: *Ontologies, Web Services, Goals,* and *Mediators*. WSML is the language that is used for the modeling of WSMO entities. WSMX is the server that is used for handling the execution environment related to services discovery, invocation, ranking and composition. The sub architectures of WSMF are shown in Figure 1.

The proposed system shown in Figure 2, is an effort based on the use of semantic web services for providing semantic process interoperability in healthcare standard HL7.

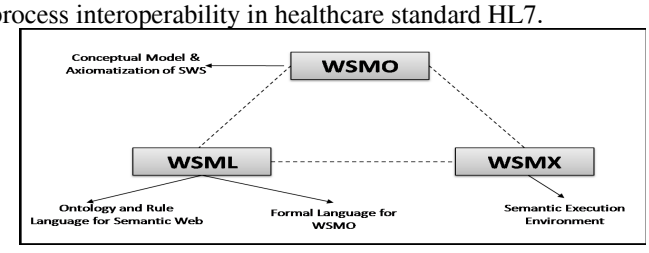

Figure 1: Web Service Modeling Framework [9]

2. System Implementation and Results

The proposed system is based on integration of Health Life Horizon (HLH) [10] architecture with WSMO architecture. Semantic process interoperability is achieved by combining the parsing, discovery, selection, invocation, reasoning, and grounding functionalities from WSMF and bringing them into the HL7 architecture. The components of the proposed systems architecture are shown in Figure 2. Initially message is generated by the *HLH Engine* component. *MessageGenerator* and *MessageParser* components are used from the *Health Life Horizon* (HLH) [10] architecture by the proposed system for the creation and parsing of HL7 message. *Adapter* component converts the message to WSML form for further processing by *WSMX*. On the other hand HLH repository is created to store the WSMO entities. WSMX uses information from *HLH Repository* to find out the appropriate service for communicating message between sender and the receiver. WSMO entity, *FindResultQueryPlacer* Goal is used to find out the appropriate service in this scenario of communicating find Result Query message. This goal will find out the *ResutQueryPlacer* semantic web service which will invoke the end point web service from web server. The overall process flow is handled by the *Interaction* and *Transmission* ontologies. *Interaction* and *Transmission* ontologies have been developed to explicitly provide specification of the process artifacts and message information respectively. *Interaction* ontology is based on HL7 interaction model which comprises of the process artifacts and their relationships with each other. The main entities of Interaction ontology are *Application Roles, Trigger Events, Interactions and Message Type*. Their relationship is depicted by properties in ontology. Application Roles sends or receives interaction. Trigger Events initiates the interaction and Message Type transfers the interaction. *Transmission* ontology is based on the information about the communication of message. The main entities of the transmission ontology are *Message, Sender, Receiver, RespondTo, ControlActProcess and Acknowledgement*. For proof of concept, the scenario of the system is based on automatic discovery of ResultQueryPlacer service for sending FindResultQuery message. *FindResultQuery* message is created for communication between the sender and receiver with the help of *ResultQueryPlacer* web service. Necessary grounding and lowering is also performed to translate the messages from XML to WSML and vice versa. The client only provides the information to the system in the form of a Goal. Seamless communication takes place in the discovery and invocation of web service on the basis of the information provided in the form of goal. The whole execution environment is handled by WSMX server. It is responsible for the discovery, selection, ranking, invocation and reasoning on the information provided to it in the form of goal. WSMX server is based on the semantic information that it obtains HLH WSMO repository. The process also works automatically due to the semantics provided by Interaction and Transmission ontologies.

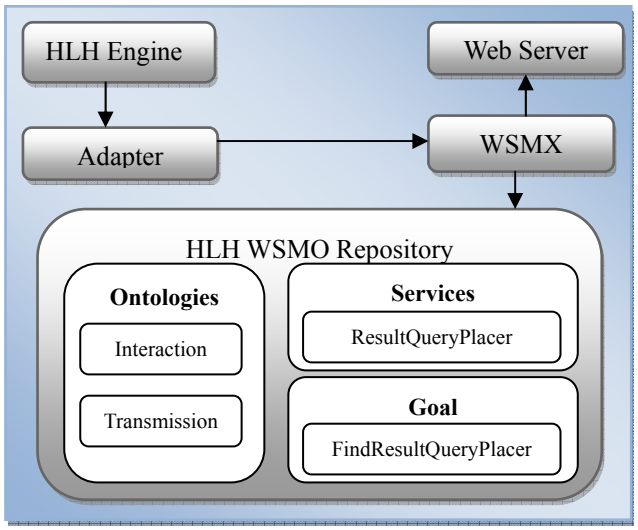

Figure 2: Proposed System Architecture

The proposed system is a cost effective, flexible and scalable solution with a strong emphasis on the importance of semantic process interoperability with semantic data interoperability. The proposed system will play an important role in bringing semantics in the *Electronic Health Records* (EHR) systems. Also mediators in WSMF architecture can be used for providing database mapping with the HL7 *Reference Information Model* (RIM) model.

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