The Importance of Health Informatics in Public Health during a Pandemic
J. Mantas et al. (Eds.)

doi:10.3233/SHTI200518

Towards an Architecture for the Interoperability of Hospital Information Systems in Burkina Faso

Lydie Simone TAPSOBA [a,1], Yaya TRAORE [b], and Sadouanouan MALO [a]
[a] *Algebra, discrete Mathematics and Informatics laboratory (LAMDI), Bobo-Dioulasso, Burkina Faso*
[b] *Mathematics and Informatics laboratory (LAMI), Ouagadougou, Burkina Faso*

Abstract. The successful introduction of ICTs into medical practice is a key factor in improving the performance of any health system for both patients and healthcare professionals. In Burkina Faso, many hospital information systems (HIS) have been developed and are already widely used in large health centers with proven efficiency. To improve the quality of patient care, these hospital information systems should exchange information. Interoperability is one of the privileged ways to improve the integration of different systems because nowadays a HIS is no longer just a single monolithic software system, which is run on a single machine. This paper presents a semantic interoperability architecture, which is based on a mediation approach. The mediator implements local domain ontologies for each HIS, a knowledge base, and a referential ontology which is used as a semantic repository and web services.

Keywords. Hospital information system, Interoperability, ontology, architecture

1. Introduction

Nowadays, many Hospital Information Systems (HIS) [1] are in operation in the major health centers most parts of the world, and more particularly in Burkina Faso [2,3]. Thanks to the electronic patient record, these systems, contribute to a better coordination of care, the collection of information relating to the patients and the improvement of the communication between health professionals [4]. For a better coordination of health services, most hospitals need to communicate by sharing of knowledge. Interoperability between hospital information systems is therefore an imperative. It has been defined in different ways in the literature [5], [6]. Interoperability between systems can therefore be summarized as the ability of these systems to exchange semantically consistent information and data which can be used by all. Different approaches to the interoperability of hospital information systems have been proposed in the literature. In [7], the authors have proposed an eHealth solution. Howerver in their approaches, systems are heterogeneous and autonomously managed making it difficult to exchange information and knowledge between different information systems. As a result, health workers face an inconsistent work environment. In [8], the author offers an interoperability solution based on Web services. According to [9], Web Services do not support semantics. So in [10], the authors propose an approach based on Semantic Web tools. However, the authors

[1] Corresponding Author, Lydie Simone Tapsoba, Algebra, discrete Mathematics and Informatics laboratory (LAMDI), Bobo-Dioulasso, Burkina Faso; E-mail: tapslyd@gmail.com.

mention some difficulties in aligning web services standards with those of the medical field. This alignment is a key factor in successful interoperability. In [11], the authors propose an interoperability solution between hospital information systems and SOA as a basis for the design, execution, deployment and invocation of services. The work of [12,13] studies the interoperability approach based on semantic services. The development of these services is also based on standards or norms in order to bring the hospital information systems into agreement with the structure of the data exchanged. There are many organizations have developed standards for medical informatics around the world. They include: HPRIM2, HL73, CEN TC2514, DICOM5 standard and the IHE6. Standard should also be noted that the XML standard is the predominant one for describing data. According to the work of [14], there are two standardisation approaches for interoperability in HIS: syntactic standards and semantic standards. The correct transmission of medical and administrative data between heterogeneous and distributed hospital information systems is based on syntactical standards [15]. These are mainly HL7 / CDA, DICOM and EDIFACT. On the other hand, semantic standards guarantee the correct interpretation of the content of the data exchanged electronically. The established standards are LOINC, SNOMED and UMLS. Unfortunately, the diversity of norms and standards poses serious problems for data integration. In this context, the authors of [16] propose that the transfer of medical data be based on international standards. A system based on IEEE 11073 for the communication of medical devices, CEN/ISO7 13606 for the modeling of health record information and then HL7 and IHE profiles for communication between hospital information systems and data storage. Furthermore, the semantic interoperability approach which is based on ontology has been studied in the work of [17]. The purpose of the semantic interoperability is to ensure that the exchanges that take place between the interconnected components retain their meaning. In our study, we propose a semantic interoperability architecture. Our approach is based on the composition and mediation of Web services. The rest of the paper is organized as follows: In section 2, we present the approach adopted as well as the architecture used by the approach. In section 3, we position our work in relation to other papers through a discussion. Finally, in section 4 we will conclude and present the prospects of our work.

2. Methods

According to [18], the composition of web services consists in combining the functionalities of several web services in a business process. Two methods of performing the composition are used: orchestration and choreography. In orchestration, a main web service takes control of the evolution of the composition and coordinates the different operations of the different web services. Choreography is not based on a main web service. Each of the services involved in the composition knows precisely what to do, when to do it and with whom to do it. Mediation is an aspect of composition [18] which is used to resolve conflicts caused by heterogeneities which may appear between web services. This is to ensure their interoperability. Mediation

[2] http://www.hprim.org
[3] https://www.hl7.org
[4] http://www.centc251.org
[5] https://www.dicomstandard.org
[6] https://www.ihe.net
[7] https://www.iso.org/obp/ui/#iso:std:iso:13606:-1:ed-1:v1:fr

tasks can be classified into three levels of mediation: data, functionalities and business processes. Our architecture is based on a set of ontologies of domains and services. An extended description of web services is made by annotating them. The purpose of this description is to link these web services to their semantic descriptions. The heart of our architecture is a semantic mediation infrastructure, supported by a web data or process mediation service. Semantic process mediation [19] is implemented by a choreography mediation algorithm which manages the conversation between services. It uses annotated descriptions, the repository of ontologies, and uses an inference engine and a rule base. It also calls for data mediation. During this mediation several syntactic and semantic mappings are executed. Figure 1 illustrates the proposed architecture. The main components are : (i) WSDM A (Web Service of Data Mediation A): the link between HIS A and the mediation system ; (ii) WSDM B (Web Service of Data Mediation B): the link between HIS B and the mediation system; (iii) LOA (Local Ontology of A): the latter is used to enrich the requests sent by Hospital A and to make the answers more understandable by Hospital A; (iv) LOB (Local Ontology of B) is used to enrich the requests sent by Hospital B and to make the answers more understandable by Hospital B; (v) WSDM (Web Service of Data Mediation) it enriches queries using syntactic and semantic mappings across the knowledge base and referential ontology; (vi) Knowledge Base is the body of knowledge (ontologies, schema rules) in the field of health in Burkina Faso, useful for enriching requests and responses; (vii) Referential Ontology is a set of existing ontologies in the medical field; (viii) the mediator is an intermediary between the different HIS. It is a software component that solves the semantic problem.

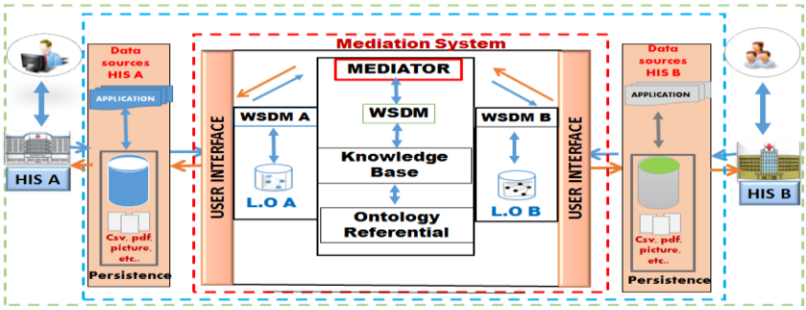

Figure 1. Architecture for the interoperability of HIS.

3. Discussion

After reading several research papers, we have distinguished two categories of approaches for the description of web services: (i) the category of approaches based on the semantic description languages which are derived from the semantic web (ii) the category of approaches which are based on annotations of descriptions of web services, which exploit the elements of existing language extensibility. The category, which is based on annotations, has more advantages than the one on the semantic description languages as long as they exploit existing standards of web services. In order to improve mediation, it is necessary to adapt the local semantic of web services to the semantics of the shared ontology. In our research, we have opted for the category based on annotations of the description of web services and a semantic model based on ontologies as well as on the notion of context. Therefore, our conceptual model allows

us to have an efficient semantic mediation because it has the following advantages: (i) there is no single representation of information (common ontology). Service providers may not be needed to adapt their local semantics (ii) semantic heterogeneities are clearly shown. They can consequently be interpreted and settled in an automatic way.

4. Conclusions and Future Work

In this paper, we have presented a classification and a comparative study of work in the field of interoperability of HIS. Following this study, we have opted for service-based approaches. Our approach is based on the annotation of the descriptions of the services by ontologies so as to propose a semantic web services-based architecture for the implementation of the interoperability mechanisms of HIS in Burkina Faso. One of the main problems encountered in the implementation of our approach is the identification of referential ontologies. In the future work, we plan to continue the implementation of the various components of the proposed architecture.

References

[1] Shekelle PG et al., Costs and benefits of health information technology, Evid Rep Technol Assess (Full Rep) 132 (2006),1–71.
[2] Golo Barro S et. al., Mise en place d'un système d'information et de codage automatisé des causes de décès dans un contexte Africain. Genève (2016).
[3] Sory TS et al., Evaluation de la performance du système d'information hospitalier du Centre Hospitalier Universitaire Yalgado Ouédraogo de Ouagadougou, Burkina Faso, Science et Technique, Sciences de la Santé (2017).
[4] Chaudhry B et al., Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. Annals of internal medicine 144 (2006), 742-52.
[5] Anne G et. al., IEEE standard computer dictionary: Compilation of IEEE standard computer glossaries. IEEE Press (1991).
[6] Carney D et. al., Topics in Interoperability: System-of-Systems Evolution. Technical Note, Univeristy of Pittsburgh, Software Engineering Institute (2005).
[7] Walker J, et. al., The Value of Health Care Information Exchange And Interoperability, Health Affairs (2005), W5-10-W5-18.
[8] Elridge D, et. al., Design For a Patient-Centric Medical Information System Using XML Web Services. Fourth International Conference on Information Technology (ITNG'07) (2007).
[9] Dogac A, et. al., A, Artemis: Deploying Semantically Enriched Web Services in the Healthcare Domain. Information System Journal 31(4) (2006), 321-339.
[10] Goldschmidt PG, HIT and MIS: implications of health information technology and medical information systems. Communication of ACM 48(10) (2005), 68–74.
[11] Kart F et al., A Distributed e-Healthcare System Based on the Service Oriented Architecture, IEEE International Conference on Services Computing (SCC 2007) (2007), 652-659.
[12] Touzi J, Aide à la conception de Système d'Information Collaboratif support de l'interopérabilité des entreprises, thèse de doctorat, Institut National Polytechnique de Toulouse, 2007.
[13] Sunyaev A, et. al., IT-Standards and Standardization Approaches in Healthcare, Encyclopedia of Healthcare Information Systems, 2008.
[14] Ali Sunyaev. Health-Care Telematics in Germany, Springer Science and Business Media LLC (2011).
[15] Mense A, et. al., Healthy Interoperability: A Standard Based Framework for Integrating Personal Monitoring and Personal Health Device Data into Medical Information Systems, Journal on Information Technology in Healthcare (2009).
[16] Khan WA, et al., An adaptive semantic based mediation system for data interoperability among Health Information Systems, J Med Syst. 38(8) (2014), 28.
[17] Karima M, et. al., Semantic interoperability of Web services: A survey, International Conference on Machine and Web Intelligence (2020).
[18] Karima M, et. al., Context-based interoperability of semantic web services, International Journal of Metadata, Semantics and Ontologies (2019).