Contextual cloud-based service oriented architecture for clinical workflow

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Abstract. Given that acceptance of systems within the healthcare domain multiple papers highlighted the importance of integrating tools with the clinical workflow. This paper analyse how clinical context management could be deployed in order to promote the adoption of cloud advanced services and within the clinical workflow. This deployment will be able to be integrated with the eHealth European Interoperability Framework promoted specifications. Throughout this paper, it is proposed a cloud-based service-oriented architecture. This architecture will implement a context management system aligned with the HL7 standard known as CCOW.

Keywords. Health information systems, eHealth, Usability

Introduction

In order to promote the acceptance of systems within the healthcare domain multiple papers highlighted the importance of integrating tools with the clinical workflow. There is a common unresolved issue in healthcare institutions when managing a large number of systems that will be required to work together within their domain. The requirements for this large number of highly specialised systems in each clinical department are impossible to be fulfilled based on single vendor software. In the current situation, healthcare providers are focusing most of their effort in providing interoperable solutions and infrastructures able to receive and transfer the information contained within Electronic Health Record systems. However, the information flow regarding clinical context management is not well addressed yet. The upcoming adoption of health related services represents an increasing need for providing solutions and new strategies in order to satisfy the usability needs for healthcare professionals.

Clinical context management

Generally, a context represents a set of independent parameters which describe a group of non-functional properties able to be shared between different systems. Within a healthcare environment, the use of different applications during patient care is a source of problems which could be reduced by sharing the relevant clinical information through a common clinical context.

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The most relevant input to address this problem was started by Duke University when they released a protocol for context management for 60 applications that required to be running on their institution. This was the starting point for developing a standard protocol called HL7 Context Management Specifications, also known as CCOW, according to its development group (Clinical Context Object Workgroup) [1] which allows different applications to be synchronized by sharing contextual information. This standard is focused on the ability to create and maintain a common clinical context between multiple applications in order to run them synchronized. This is obtained with centralized architecture with two main elements:

- The Context Manager: is the central node that create and maintain the clinical context between the different applications;

- The Context Participants: those applications that will run separately on the system.

By sharing this common clinical context between both actors, CCOW will provide included applications with additional features and functionalities. These functionalities allow to increment the usability of different health applications within a workstation, the increased efficiency and productivity of the clinical processes, the development of safer work environments by providing confident mechanisms to be authenticated in the whole context, or even the reduction of failures associated to the lack of synchronization between applications.

The CCOW proposal for the development of the context management system enables both settings based on client-server and web-based applications. These approaches allow us to define a specific strategy for the development of a context management system within health environments. This strategy is based on the deployment of a service-oriented architecture (SOA) [2][3]. The conjunction of this kind of architecture with a context aware implementation like CCOW will provide us a flexible and scalable environment able to provide the capability of sharing a common clinical context over a global access network like the corporative network of a hospital or ever the Internet. This feature will help the whole system to extend the common clinical context without limits, changing the initial implementation of CCOW to a higher level and increasing the accessibility to the contextual information for all systems subscribed to the clinical context [4].

Health Related Cloud based Services

The large variety of health related cloud based services that are usually provided by private companies direct to consumer such as Microsoft Health Vault, 23andMe, Google genomics, mobile applications, wearable devices and monitoring devices for lifestyle and chronic condition will create multiple scenarios where clinicians would require to review patient information that is contained within patient Personal Health Record Systems. Another relevant example are initiatives like the IMIA Health Record Banking Working Group which claims the need for creating public-private on the role of 'Trusted Third Parties' for containing healthcare information. Even in case that some relevant information from PHR could be transferred to hospital EHR systems the large variety of applications would make unaffordable for hospital information systems to provide the same quality of screen functionalities and usability for information display than those applications that generate the information. The amount of effort required for

replicating the presentation capabilities of those cloud based services highlight the need for addressing a scenario where clinician would require to review clinical information from systems hosted within the hospital infrastructure and cloud based services.

Data Protection, Privacy and Security

Within our proposed scenario Data Protection Directive 95/46/EC and security issues could be satisfied according to multiple technical solutions such as management the privacy and access level within each application at local level with the identification of the user or single-sign-on technologies. As part of this paper the multiple options for addressing privacy and security issues since this is a problem that is out of the scope of context management.

1. Methods

This paper aims to analyse how clinical context management could be deployed in order to promote the adoption of cloud advanced services within a clinical workflow. This deployment will be able to be aligned with the specifications promoted by the eHealth European Interoperability Framework. Throughout this paper, it is proposed a contextual cloud-based service-oriented architecture within a clinical workflow aligned making use of the HL7 standard known as CCOW.

2. Results

2.1. CCOW as a web service

In order to implement the development of the CCOW web service, an approach based on WSDL/SOAP is proposed. This strategy will enable the differentiation between the context manager deployment and the healthcare.

The following terms have been identified as able to provide a common frame when managing a clinical context:

- User: healthcare professional identification within a workstation.
- Document id: document identifier in a document source.
- Application: specific application within the context management system.
- Patient: unique patient identification between different clinical information systems.

In order to define the set of operations that should be carried out during the context life cycle, most of the interfaces defined in the CCOW standard should have to be implemented. Each one of these interfaces will execute one of the procedures available over context such as (i) application authentication, (ii) capabilities for query and modification multiple information element existing in the context, (iii) synchronising one application according to the changes performed within the context and context session closing. For each of the operations defined in CCOW for interacting with context it will be required to define an independent web service.

2.2. Patient identifier management

Under this new approach, it is necessary to point out some aspects related to the use of patient identifiers and the document identifiers. For the first of them, this proposal recommend the development of a standardized profile which map in a centralized manner the patient identifiers associated to the different possible clinical domains. This standard profile was defined by the IHE under the name Patient Identifier Cross Referencing (PIX) [5]. To achieve the patient identifier mapping task, the standard promotes the use of a set of standardized messages that will communicate with a central master patient index (MPI).

2.3. Document identifier management

Similarly, to associate clinical documents to a concrete patient another auxiliary system is needed. For this reason, this paper also proposes another IHE standardized profile but, in this case, to ensure the document identifier management, known as Cross-Enterprise Document Sharing (XDS) [6]. By means of this standard, we will be able to identificate and map document identifiers associated to a concrete patient through the different document sources available. To achieve this task, a Document Registry will be deployed with the different document identifiers which will be used as a link toward the file stored in a central Document Repository

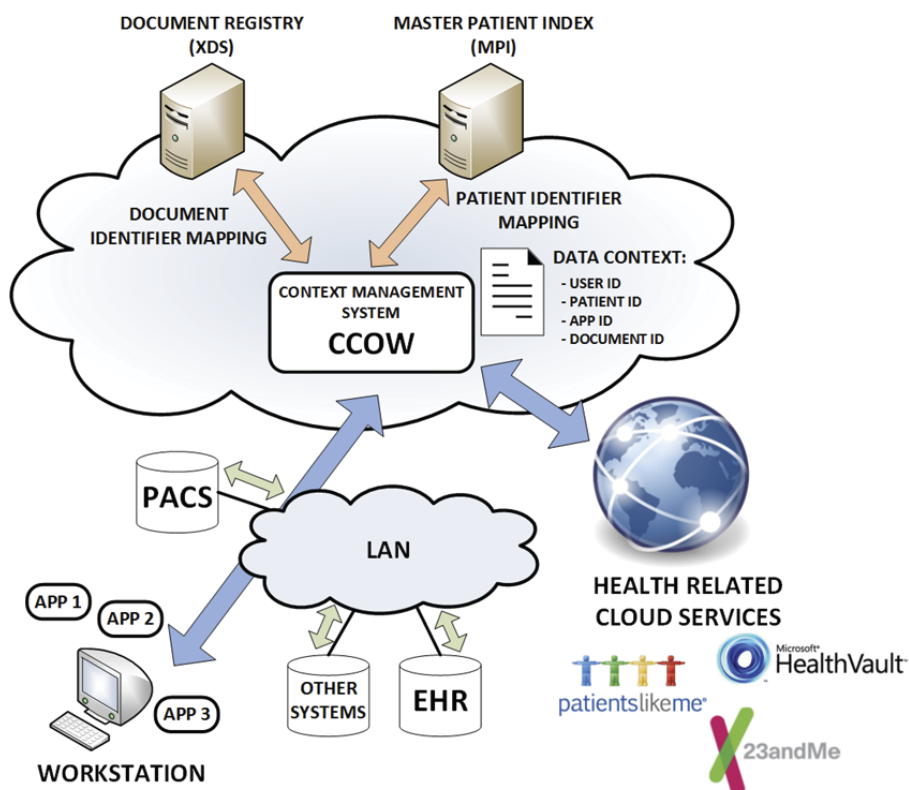To illustrate the proposed architecture, it is shown the following scenario:

Figure 1. Conceptual model of the scenario.

3. Discussion

The proposed approach for developing and deploying a contextual cloud-based service oriented architecture for clinical workflow represent an increased advance in terms of usability driven by the synchronization capabilities within the large amount of clinical applications that are daily used in the healthcare delivery practice. This could be a proper solution to incorporate new strategies for integration of advanced health-related cloud-based services in a clinical workflow. Aligned with the promotion of empowerment strategies for patients in their active role for self-management of health diseases and conditions, it is expected to increase the importance of cloud-based services. As a result, new strategies for clinical context management would require a more relevant role in forthcoming healthcare information systems, being complementary to current standards for EHR communication.

As a part of our proposal, we identified how the most relevant terms for clinical context management could be integrated and managed by means of standards and profiles in health informatics. In the selection of specifications for clinical context manager deployment we selected those profiles included as part of the European eHealth Interoperability Framework (EIF). This could be promoted to create an additional use case in future revisions of the EIF for clinical context management in order to foster the implementation of an eHealth Network that would help to build an European level eHealth market.

In order to implement the proposed framework, it was made a feasibility study to analyse the implementation CCOW based context management system to provide better integration of context between HCE and a system for surgical planning. The results of this study will be applied to integrate and manage the context of a set of six software tools as research suite platform called ITC-Bio, funded by the Spanish Ministry of Economy and Competiveness (Code FPAP13-1E-2429) .

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