INTERNATIONAL JOURNAL OF MEDICAL INFORMATICS 75 (2006) 671–682

journal homepage: www.intl.elsevierhealth.com/journals/ijmi

Demographic management in a federated healthcare environment

I. Román[a,*], *L.M. Roa*[b], *J. Reina-Tosina*[c], *G. Madinabeitia*[a]

[a] *Group of Telematic Engineering, University of Seville, Spain*
[b] *Biomedical Engineering Group, University of Seville, Spain*
[c] *Department of Signal Theory and Communications, University of Seville, Escuela Superior de Ingenieros, C. de los Descubrimientos, s/n 41092 Sevilla, Spain*

ARTICLE INFO

Article history:
Received 30 September 2005
Received in revised form 19 April 2006
Accepted 19 April 2006

Keywords:
Demographic service
Person identification
EHR
Federated systems
Standardization
Ontologies

ABSTRACT

Objective: The purpose of this paper is to provide a further step toward the decentralization of identification and demographic information about persons by solving issues related to the integration of demographic agents in a federated healthcare environment. The aim is to identify a particular person in every system of a federation and to obtain a unified view of his/her demographic information stored in different locations.
Method: This work is based on semantic models and techniques, and pursues the reconciliation of several current standardization works including ITU-T's Open Distributed Processing, CEN's prEN 12967, OpenEHR's dual and reference models, CEN's General Purpose Information Components and CORBAmed's PID service.
Results: We propose a new paradigm for the management of person identification and demographic data, based on the development of an open architecture of specialized distributed components together with the incorporation of techniques for the efficient management of domain ontologies, in order to have a federated demographic service. This new service enhances previous correlation solutions sharing ideas with different standards and domains like semantic techniques and database systems. The federation philosophy enforces us to devise solutions to the semantic, functional and instance incompatibilities in our approach.
Conclusion: Although this work is based on several models and standards, we have improved them by combining their contributions and developing a federated architecture that does not require the centralization of demographic information. The solution is thus a good approach to face integration problems and the applied methodology can be easily extended to other tasks involved in the healthcare organization.

1. Introduction

1.1. *Federated healthcare systems*

Throughout everybody's lifetime, any person may have episodes of care assisted by many health-care professionals. This is mainly due to the increasingly specialization of medicine practice and to the growth of population mobility, among other factors. On the other hand, new information and communication technologies (ICT) are being applied in healthcare tasks making these easier and more efficient. The extensive use of ICT is having a clear impact in the transition to the digital hospital [1] being the management of multimedia clinical information systems an essential issue.

* *Corresponding author*. Tel.: +34 954487384; fax: +34 954487385.
E-mail address: isabel@trajano.us.es (I. Román).

1386-5056/$ – see front matter © 2006 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ijmedinf.2006.04.006

In this new scenario, patient's clinical information is distributed among several information systems, geographically dispersed. Usually, these are autonomous and heterogeneous systems developed under different objectives, and consequently with diverse data models, platforms, standards and semantics. In the best conditions, they could follow a standard, but different ones could be selected for each system. The compilation, visualization and management of the distributed clinical information related to a patient can ease the healthcare professional tasks and improve the quality of service. The query of this information to give a single, coherent and contextualized record of the EHR needs that these legacy systems work in a collaborative environment. When the autonomy of the systems has to be maintained collaboration is needed in a federated approach [2–4] and the resolution of incompatibilities between the systems of the federation must be accomplished. These conflicts can be classified into three levels [5–11]:

- Semantic: the information models or database schemas are different.
- Functional: the interfaces to manage data are different.
- Instance: the information about the same real entity could differ from one system to another [12].

The large number of applications, mutually isolated and incompatible, that are already available in the market, installed, and operational in healthcare organizations, effectively supporting specific needs of users cannot be underestimated. Under the present circumstances, a critical issue is to make possible the integration and interoperability of already existing applications thereby securing investments already made and allowing continuity of the service whilst facilitating a gradual migration of existing proprietary, monolithic systems towards the new concepts of openness and modularity. The cost-effectiveness of the solutions, especially when projected on the scale of the whole organization, represents another crucial aspect to be evaluated carefully [13]. Several groups and standard organizations are making efforts to solve these integration and interoperability problems [14–17].

1.2. *Demographic services*

In order to collect the patient's healthcare information within an autonomous system from the federation, the patient must be uniquely identified first. Usually a system will allow the user to submit a search for a patient's record using some combination of identity parameters for that person [18] and when the identification is finished this is translated into a unique identifier (PersonID) used in the whole system to reference this patient.

The assignment and maintenance of PersonIDs is frequently local to the system. This management style suits the purposes of recording and retrieval of patient's records inside the local domain. However, the efficient collection or correlation of health records in a federated context requires more sophisticated identification and PersonID management processes.

For the management of EHR in a federated scenario the person has to be correctly identified in every system. An obstacle for this identification is the lack of a unique person identifier. Some administrative identifiers, as Social Security Number, National Identity Document, Passport Number, or Car Driver License could be considered, but systems usually manage a local PersonID independent from these administrative identifiers because there is no guarantee about the existence of them for every registered person [19]. Especially in international scenarios, where many different administrative domains are involved, this difficulty increases. To keep the autonomy of the systems, this consideration has to be maintained when an open integration solution is developed.

After the identification of the person, the demographic data about the patient has to be requested over the federation in order to have a unique view of his/her demographic knowledge. Only after these first tasks, which are carried out by demographic components, the whole EHR would be visualized [20]. The importance of these components, which objective is to manage the identification of a person and the query of his/her demographic data, is thus justified.

In addition, it is important to emphasize that, if the developed methods are not centered in the patient but in the identification of every person involved in the healthcare organization, and if a well designed component-oriented approximation is adopted, the results could be reused in different activities inside the organization, for example in security or healthcare staff management, and not only in those directly related to the EHR management.

1.3. *Semantic conflicts in a federation of demographic components*

When demographic components are designed independently, they could have different database schemas and could manage different concepts and data types. Interoperability is only possible if previously they are agreeing in a common semantic of the managed concepts. This agreement could be established in the specification of an ontology, which describes the domain concepts and the relation among them.

For example, one system can store the age of a person as "age", another can manage "birth date" and a third one can use the Spanish term "edad" to represent this concept. The common ontology should include the concepts "age" and "birth date", and the relation between them. This way, the dialogue between two different components that manage these two concepts will be possible, understanding the information recovered from each one and facilitating the integration of this information. A component that understood the "edad" concept has to make the mapping to the "age" concept when it is interacting in federated workflows. Ontology management methods could simplify the management of relations between concepts and the mapping from local to federated concepts.

In our framework the common ontology to describe the demographic knowledge is based on CEN [21,22], OpenEHR [23] and CORBAmed Person Identification Service (PIDS) [18] information models, which are described in Section 2. We use OWL as ontology language because it is the standard proposed by the Web 3 Consortium (W3C) [24,25] and thus the reusability of our solution will be improved. Several research groups in medical informatics are using this language in their works [26–29].