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A core middleware service in H.I.S.: the experience of IC_PIDRM

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Abstract. The exploding usage of telematics and internet techniques also in the Health Care environment imposes a re-thinking of the basic services that an Information System should provide. The standard CEN TC251 HISA ENV 12967, "Health Information System Architecture" while addressing specifications for patient coherent identification between departmental and global hospital information systems, leaves a cloud of uncertainty about inter hospital information system collaboration, delegating a pure technological layer (the so called "bitway" layer) to solve communication and interactions. The faced reality of heterogeneous systems in a regional healthcare environment drives the design of an architecture that includes functional middleware services implemented to create co-operation among several local identification systems and laying on a technical platform able to deal with distribution. This article explains how the InterCare HC4011 project designed and tested such services, and the conclusions reached.

1. The approach to Patient Identification Services in InterCare Project

In analysing "business" and processes requirements for a regional, multi-user and multi-provider seamless care system[1], the attention is generally focussed on the mechanisms to be put in place for having at disposal and managing medical data. In the reality, this approach under-estimates or considers already solved the fact that in a patient-centric design of a health information system, all those data must be recollected and associated to the main subject of interest in all the health care processes, that is the patient. The patient must be at least recognised in a virtually unique and coherent manner inside a wide distributed system, that means among different legacy systems, each one with its own characteristics (see fig.1). So, a Patient Identification system must support interaction and federation among systems for what is concerning with different coding attributed to patient identifiers and services for alignment of demographic data[2]. This well complies with the administrative needs in a network of health care organisations.

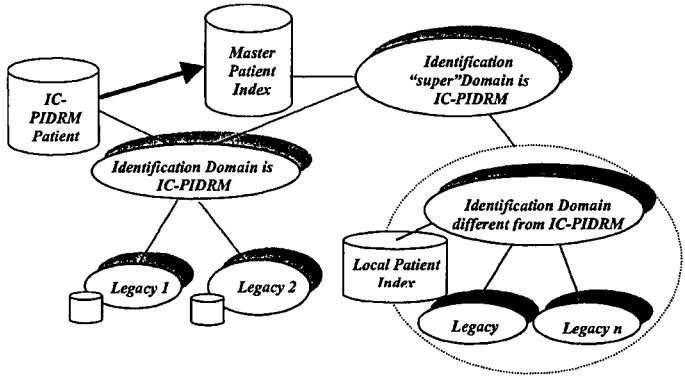

Fig. 1: Relations among different identification domains and their possible hierarchies

But the identification support does not satisfy all the requirements in place: in fact, the patient identification and demographics data have a value in the care process when they are seen in relation with episodes of care or contacts the patient had with health care professionals. Even if medical information can be acquired invoking other most specialised services (the InterCare Electronic Patient Dossier Server is the delegated one in the current project) aiming to support a regional Virtual Health Care Record, some technical and practical threats should be considered when leaving a lab or a single hospital system and moving to a wide regional health care network. This assumption needs an exemplary explanation: let's consider a physician requiring a view of the diabetes episodes related to a patient occurred in a certain period in all the hospitals and outpatient care structures in a region (several tens) connected in a virtual private network. We can understand the processing work necessary for interrogating all the systems in their interfaces, building a view of the virtual health care record and presenting the information, in a browser, maybe having at disposal a simple ISDN connection (or probably a slower one). Response time becomes critical for acceptability of the service.

For solving this problem and other similar ones, it was considered important to complement the pure identification services with a common repository in which very limited but significant abstract, acting as references to the a local patient dossier systems can be inserted when generated. Due to the non specific characterisation of such repository for contact or episodes, it was called "reference entry. In this manner, every request for medical data can be better specified and the user can be referenced to precise objects and instances of such objects, instead of exploring globally what is at disposal in the health care network.

From these considerations, Patient Identification Services in InterCare have incorporated also facilities for Reference Management.

Having done so, another necessary extension to the initial identification model emerged: recording abstracts of reference entries implies also the recording of minimal identification of agents – in this particular case health care professionals – responsible for storing the patient related information in their own systems. It is evident that, considering the pre-conditions assumed of a wide, distributed and heterogeneous group of systems connected in the network, the same problems of identification of the patient must be solved also for the care providers. So, in parallel with the services for supporting patient identification, similar services must exist for "agents" identification. For a matter of shortness of this article, the latter will be not treated here under.

2. Design and implementation of Patient IDentification & Reference Manager - IC_PIDRM

When approaching an architecture for wide heterogeneous and distributed systems to be interconnected, the base infrastructure services assume a vital role. So, what can be considered a pure technical infrastructure relegated in a neutral "bitway" layer, as such services are defined in the TC251 HISA ENV 12967[3], becomes necessary enabling mechanisms for some transactional services in an on-line integrated networked system. Because the complexity of the regional network of health care organisations co-operating in the care process is high and legacy systems should be added or taken out of the network depending from regional authorities policies, the architecture of the system should be open, scalable and should support as possible the sharing or viewing of "live" data, a message – oriented approach, utilising Electronic Data Interchange standards has been discarded. Due to the potential mobility of the patient from health care organisation to health care organisation, from health care professional to health care professional and from primary to secondary care, results quite impossible to design (even if technically easier to implement) a message oriented network. Moreover, messaging systems cannot grant total alignment or coherence of data exchanged in a multi-user network, limiting

their control from point to defined points in the net, requesting data "moving" and replication and loosing the potential sense of a regional virtual health care record.

From the merging technologies nowadays, the support services given to distributed processing environment by CORBA[4] (Common Object request Broker Architecture) specifications result the most coherent for the implementation of a Patient identification and Reference Manager server in a regional health care network.

On such basis, the design of the server has been done for fitting into and for exploit a CORBA platform. UML (Unified – someone says Universal – Modelling Language) formalisms have been used for specifying processes to be supported (via "use cases" and sequence diagrams definitions) and a related logical object model (via "class diagrams").

The consolidation of these two models has produced the specification of the interfaces to be implemented, defined in IDL (Interface Definition Language) and their organisation in system's components. The IDL specifications[5] have been then given for processing to an ORB (Object Request Broker) software, deriving the basic coding structures for their implementation (skeleton of the server side, stubs on the client side). Their implementation has been completed using both Java and/or C++ languages, granting portability on different platforms.

The services implemented under InterCare project under the guidance of the previously exposed approach resulted in a set of dedicated components, coherent with CORBAMed specifications for Person Identification Services[6], and dealing with:

Identification: the IC_PIDRM supports the identification of patients cared, and whom information are stored, in a specific local system, with the possibility of uniquely identifying them also without the knowledge of the system's specific identification applied. This can be done both using other local system's specific identifiers and with complete or incomplete patient demographics.

ID Correlation: the IC_PIDRM supports correlation of Ids associated to patients that received care in different settings, and addresses the problems of correlating Ids among different Ids Domains.

Reference Entries Management: the IC_PIDRM, despite the local coding of registration of episodes or contacts data in local systems, maintains and links to patients, a limited abstract of such "entries" in such a way to provide orientation and facilitating the retrieval of information in several legacy systems existing in the network.

3. Trials and experiences

After the implementation and testing in lab environment, the preparation for some practical testing has been done. A pilot site in Italy, Lombardia Region, has been activated where the IC_PIDRM has been used as mediator among three different identification domains where present: a Regional Patient Index under a UNIX partition of an IBM mainframe, hosted under Oracle 8 RDBMS, a hospital Patient Administration Server with data stored in a MS-SQL Server 6.5 under NT 4.0and a DHE® platform with a Patient Manager Server[7], as well as an Act Manager Server (accordingly with the specifications of CEN TC251 HISA ENV 12967) running in an original Unix environment with the last release of Sybase as RDBMS. The Implementation of the archives of IC_PIDRM were supported by an MS-SQL Server 7.0 running on an NT 4.0. Due to the usage of a public infrastructure for communication, even if virtualised in a Virtual Private Network, and the need of light (thin) clients hosted in a browser for the application, a MS-Internet Information Server has been used as web. Clients, as said, have been built in Java, using JDK 1.1.8 for being directly supported in the most diffused browsers without any need of heavy download of libraries in the Java Virtual Machine natively incorporated. The approach undertaken in implementation of the client made use of a "servlet" based application architecture.

In this scenario, a commercial CORBA platform, namely OrbixWeb 3.1 by IONA has been used for offering the needed Object Request Broker facilities and establishing a transparent distribution environment. The different technical implementation of the three identification system has imposed to develop different interfacing strategies: for the Regional Patient Index a custom implementation of the IC_PIDRM services interfaces has been done; for the Patient Administration System in the hospital, a wrapping has been used to accomodate functionality to respond to the IDL specifications implemented; finally, for the DHE® servers, a direct encapsulation of some already provided services in C language has been done to comply with the Java implemented interfaces.

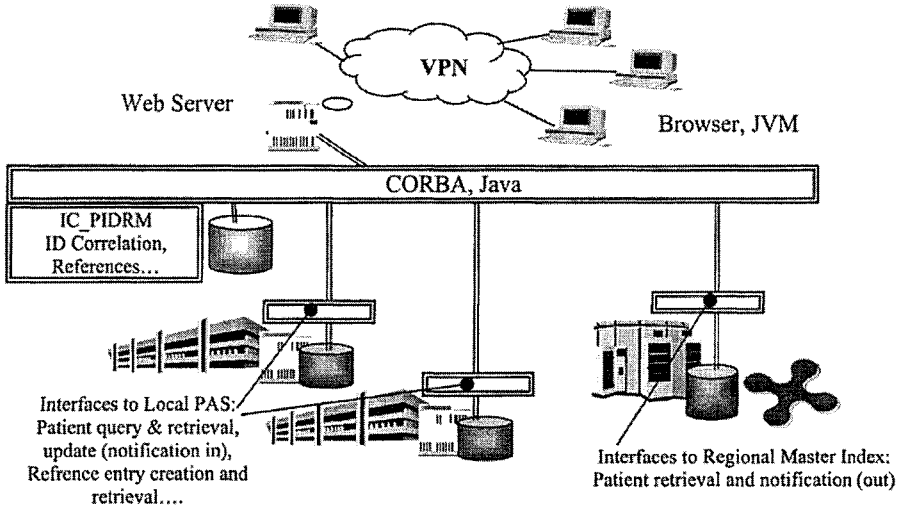

Fig. 2: Architectural sketch of the tested scenario for IC_PIDRM

Different IC_PIDRM services have been activated in this scenario (see fig. 2) accordingly with the scope and the characteristics of the identification domains faced.

In particular, the Regional Patient Archive has been seen as a Master Patient Index, where has been maintained its own functions for the maintenance of the data, via dedicated applications. The IC_PIDRM services interfacing such archive had then to be focussed on information retrieval and notification of updates to the other two systems. The other two systems, on the other hand, has been tested under the requirements of maintenance of their own internal identification mechanisms and coding, answer to the requests and presentation of patient information as identified by the requesting "alien" system, generating reference entries and proving the access to them in a coherent manner as stored in their local, different software structures.

4. Conclusions

The trials in real environment have been launched and will continue until the middle of year 2000 for collecting a comprehensive evaluation report and permitting further refinement of IC-PIDRM services. Already now it is possible to draw some anticipated conclusions from the emerging evidences.

First evidence is organisational: ICT is an enabling factor for improvement of care delivery and this is not under discussion. Anyway ICT in health care sometimes find a non mature cultural and technical environment for its exploitation. When trying to put in place a large regional networked health care system, the various organisations to be interconnected are widely different in terms of preparation support and infrastructures for being ready to adopt a new generation of telematics services. There is no other manner than improving Regional Authorities IT plans, policies and investments for translating interesting experiences into reality.

Second evidence is technological: distribution platforms as CORBA have a great potential to solve problems related to the implementation of wide regional networks. Unfortunately, the technology is still difficult and the skills available in the health care sector are not enough. CORBA has been used up to now for more profitable market sectors for industries (i.e. the banking sector or telecommunication sector) and experiences in health care are absolutely limited, in such a way that knowledge is difficult to find and to be transferred.

Third evidence is related to standards: the current CEN standards for Health Information System Architecture have not yet formalised completely the conceptual, logical and technological requirements for the characteristics of regional health care networks. Technology is running faster than standardisation and, unfortunately without any prescriptive policy on standard adoption by Regional Health Authorities, health care organisations have more pushes to follow market technical trends than standards (or in the worst case, not to follow anything).

Finally, something more related to the functional scope of IC_PIDRM: this core services, aggregated to other InterCare project services[8] (like the InterCare Access Control Server for authorisation, and InterCare Electronic Patient Dossier Server for Virtual HealthCare Record) demonstrated a way to solve some of the requirements imposed by new regional health care systems. What is important to notice is that, as briefly indicated for the identification of agents in the net, identification services, in their extended context of unique and understandable retrieval and correlation of information about a subject, need the presence of master indexes: this is valid not only for patients and agents, but also for medical information (several classifications used in different systems) and administrative information (i.e. coding system used for indicating address information where municipality can be classified accordingly with different coding systems). Another interesting aspect is related to the increasing introduction in health care of smart cards, holding patient data: in this case also the cards can be seen as representing an identification domain to be interfaced.

The faced needs to extend the services from Patient Identification to more general "Identification" services in health care represent one of the lines of development to be followed for creating and expanding seamless care regional networks in Europe.

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