Introducing Distributed Objects in a Healthcare Institution: The Hospital das Clínicas CorbaLab Project

Fabiane Bizinella Nardon, MSc; Lincoln Moura, MSc, PhD; Juliano Claudio Zanardo, BSc; Américo Cordula Teixeira, BSc; Regina Claudia Cantele, BSc

Hospital das Clínicas – University of Sao Paulo Medical School Hospital, Sao Paulo (SP), Brazil

Abstract

This paper describes the experience of the University of Sao Paulo Medical School Hospital (Hospital das Clínicas - HC) in introducing Distributed Objects technology in a large healthcare institution. HC has six independent institutes using different information systems running on different platforms. Aiming at providing a higher level of integration among these heterogeneous systems, the hospital created a distributed object project which has been referred to as the CorbaLab project. The goal of that project is to introduce distributed objects technology in the institution. The process, difficulties and results of this project are presented in this paper.

Keywords:
Distributed Objects; Software Components; CORBA; Hospital Information Systems

Introduction

University of Sao Paulo Medical School Hospital (HC) is the largest hospital in Latin America and is among the largest in the world. It has about 2,200 beds, provides care for more than 90,000 outpatients each month, and performs about 1,000,000 laboratory exams per month. HC has six independent institutes using different information systems running on different platforms.

Currently, HC is renewing its informatics infrastructure, building a new information system that will improve the information management and, consequently, improve the patient care.

The new system handles the corporation information, managing an enterprise-wide database. At the same time, the new infrastructure is giving strength and freedom to the institutes, encouraging them to translate into their needs the benefits given by the corporate information system. This approach decentralizes the informatics services and let the institutes to choose the way their specific systems will be obtained: through internal development or through buying the best product from the best vendor.

This process of renovation is committed to the use of open standards in all layers of the infrastructure. Moreover, there is a partnership with other healthcare institutions with the same problems, which makes this project a multi institutional one.

Thus, the University of Sao Paulo Medical School Hospital information system emerges as a totally distributed system, where the exchange of information among different healthcare institutions allows improving patient care and information management.

This distributed and heterogeneous environment requires the utilization of technologies that permit to integrate systems running on a wide variety of hardware and software platforms. Distributed objects technology [1] has been pointed out as the only way to provide true integration [2] among heterogeneous systems.

Introducing Distributed Objects technology in a large institution, however, implies in changing the way systems are made and in learning a new way of thinking. This new paradigm has to be introduced gradually and a great deal of time has to be spent in training developers and disseminating knowledge. To achieve this goal, University of Sao Paulo Medical School Hospital created the CorbaLab Project. This project aims to introduce distributed objects technology in the hospital through pilot projects, training and knowledge acquisition.

This paper describes HC experience in the process of introducing distributed objects in a very large and complex healthcare institution.

Distributed Objects in Healthcare

Along their lives, people receive treatment in many different healthcare institutions. Each institution stores the patient's information in its own database, using its own data structures and a specific hardware and software platform. Even inside a single institution, the increasing number of specialized units has caused increased fragmentation and distribution of patient records.

This scenario makes healthcare information systems an inherently distributed application.

The growth of Internet connections and the need to provide better care at lower cost have made it increasingly important to access the complete health care record of people.

To make it possible to recover the complete patient health record it is necessary to provide means of interoperability among the various existing software and hardware platforms. It is well known that we are not going to have a consensus of hardware, software or data structures. Different institutions will certainly continue to use different architectures.

The solution to providing interoperability among different systems is to use an architecture that permits different software applications running on different platforms to communicate with each other. Distributed object architectures have been pointed out as the only way to provide true integration among heterogeneous systems [2]. In a distributed object architecture [1], independent pieces of software can be accessed by remote clients via method invocation. Using a standard that makes transparent the communication issues among distributed objects, different applications running on different platforms can interoperate without wasting time in building proprietary solutions of interoperability.

Nowadays, CORBA 2.0 [3] is the standard that offers the necessary infrastructure to achieve this interoperability. CORBA (Common Object Request Broker Architecture) is the most important middleware project ever undertaken by the industry [1]. CORBA was defined by the OMG (Object Management Group), a consortium of more than 800 companies around the world. Through CORBA, distributed objects can discover each other and communicate regardless of the hardware, operational system or programming language used by the involved applications.

Only the CORBA infrastructure, however, is not enough to integrate successfully healthcare applications. It is also necessary to use domain standards and to define an efficient methodology for creating the distributed objects that are going to be used in the healthcare industry.

The OMG Healthcare Domain Task Force, also known as CORBAmed, has made an effort to standardize services in the healthcare domain. Until now, CORBAmed has two adopted specifications: the Person/Patient Identification Service (PIDS) and the Lexicon Query Service (LQS). The first provides a standard method for locating person identifiers and their associated records across facilities and enterprises. The second supports queries over multiple vocabularies in a heterogeneous application environment. There are other CORBAmed specifications under way, but much more is needed to provide the level of standard interoperability among healthcare applications we need.

Even with a good level of acceptance of distributed objects technology, the process of introducing this new paradigm in a large institution is not trivial. First of all, there are not enough experienced distributed object-oriented designers available. Second, there are but a few good tools to support this work. Third, it is necessary to design each distributed object in a way to allow maximum reuse. The most difficult issue is, however, to change the minds and hearts of a huge number of developers used to traditional techniques of building applications.

The CorbaLab Project

The environment of the University of Sao Paulo Medical School Hospital is distributed and heterogeneous. Each institute counts on an independent team of informaticians and is free to choose the way its specific systems are implemented. The Center of Information and Analysis (CIA) is the department in the Hospital responsible for managing and coordinating corporate projects. CIA is also responsible for introducing new technologies in the institution and for providing the necessary training, allowing the independent teams of developers to have access to new technologies and improving the general quality of the systems produced in the hospital.

Envisioning that distributed objects is the technology that will provide the level of interoperability we need, CIA started in 1998 the CorbaLab project. This project has as major goal to create a culture of utilization of distributed objects in the hospital.

The environment the CorbaLab project has to deal with is extremely challenging. Most of the developers have no experience in any object-oriented technique. Systems used by the institutes are made in a wide variety of programming languages (Borland Delphi, Microsoft Visual Basic, Oracle Forms, C++, Fox-pro, Clipper, Magic, etc), running on different operational systems (Windows 95, Windows NT, Unix, Solaris) and different hardware platforms (Intel PC, Sun, Digital). As the institutes are independents, technology can not be

imposed, nor would it be desirable. Our task is to open way to technologies and methods that attract institutes to integrate without losing their individual characteristics and independence.

The success of the CorbaLab Project depends on the level of acceptance distributed objects technology will achieve. The strategy of this project is to promote the benefits of using distributed objects, producing the necessary knowledge in the process. The project is based on the following tasks:

1. Promote seminars and presentations to introduce the technology in a high level;
2. Promote training at various levels of depth;
3. Participate in national and international initiatives of standardization of distributed objects services;
4. Create a pilot project to implement CORBA-based services;
5. Stimulate the independent teams to use software components in their development;
6. Support master and PhD thesis in the field;
7. Make partnerships with others healthcare institutions to interchange specifications, design patterns and software components.

When starting the introduction of a new technology it is very important to make people believe in it. Seminars and presentations promoted by the CorbaLab project have been used to show off the benefits of distributed objects and the importance of using standards and well designed software components. These seminars are presented to heterogeneous audiences, including developers, managers, physicians interested in informatics and PhD students. While they didn't give a solid formation on the subject, seminars increased a lot the level of acceptance of distributed objects technology. Today, the work of the CorbaLab team is well known within the hospital and there is a growing expectation about the possibility of applying the results of the project in the hospital.

Training of developers is fundamental in our environment. As they don't have knowledge of distributed objects technology, a lot of time has to be spent in courses and training. Usually, the institutes choose one or two developers to participate of the training. These people will later multiply the knowledge acquired in their environments. In this training, developers are encouraged to use standards and to produce software components designed to be reused in different contexts.

The participation in national and international efforts of standardization gives us the chance of influencing the new standards being made and, at the same time, the chance of being updated with the last emerging standards. At a national basis, HC is one of the founders of the Brazilian Consortium of Software Components in Healthcare (www.sbis.epm.br/ccssus/). This consortium reunites Brazilian healthcare institutions, vendors and government organizations, aiming to standardize software components in healthcare and to be a repository of software components that can be exchanged among the institutions. At an international basis, HC participates in OMG CORBAmed, being one of the Healthcare Data Interpretation Facility specification submitters and one of the coordinators of the CORBAmed Latin American Chapter.

Knowledge is the most important product of CorbaLab project. However, to produce knowledge and to prove the adequacy of the technology, we need a pilot project where a useful implementation is done. In CorbaLab, we chose as the pilot project an implementation of the CORBAmed PIDS specification. This choice was made based on three factors: first, PIDS was obviously extremely useful in our environment; second, it was the first CORBAmed adopted specification and the only one completely finished by the beginning of the project; and third, there was a huge interest of many healthcare institutions in Brazil in using PIDS to identify their patients; and this was one of the goals of the Consortium of Software Components.

When the PIDS implementation started, there was a preoccupation of making available small and useful software components to stimulate the various teams of developers to use these components in their applications, starting this way a culture of modularization and reuse. Thus, we identified several individual components in the modeling of our PIDS implementation. The idea is to implement these components gradually, making them available as individual pieces of software, and then put all them together to build the PIDS service. We prioritized the implementation of those software components that could be used rapidly in the larger number of applications. Thus, the first component implemented was the one that did the phonetic treatment of a person's name, used in the IdentifyPerson interface of the PIDS specification. There was a preoccupation of modeling the components in a way to allow maximum reuse. The

components had to be context independent, what means that they could be used in many unexpected different contexts, had to use design patterns [4] whenever possible, and had to be deployed in a way to permit their rapid incorporation in a large number of applications. As a result, the phonetic component can be used not only for person's name, but also for addresses, disease names, and so on. To permit rapid incorporation of the components in the institutes' applications, the components were built in java and deployed as JavaBeans, CORBA and ActiveX components. This way, a large number of applications could use the components without dramatic architecture changes in this first moment.

Being an academic hospital, HCFMUSP has supported master and PhD thesis in medical informatics. These thesis are important because their results can be applied to the hospital and because the students can help in the development of our pilot projects. Currently, we have five Ph.D. thesis under way, all of them issuing the application of distributed objects in healthcare.

Our institution is not the only one looking for a better information system and it is not the only one working on distributed objects. In an era where healthcare institutions have to exchange information to provide a better care and to decrease costs, it is also necessary to exchange specifications, design patterns and software components to increase the productivity in the process of making software. Thus, partnership with others healthcare institutions is a very important issue in this project. Today, we have with our partners a forum where we can discuss our models, patterns and technical issues.

With the CorbaLab Project acting as an environment to test, learn and teach distributed objects technology, it was necessary to start gradually the introduction of these concepts in the real systems used in our hospital. Despite the current corporation systems being built using non object-oriented methodologies, there has always been a commitment to evolution towards a distributed objects architecture. To introduce PIDS and componentization concepts in the corporate information system, we designed all patient identification issues according to the PIDS specification, creating procedures that performed the PIDS functions, receiving the specified parameters and giving the specified outputs. Thus, despite the fact that the current system is not based on a distributed object architecture, it is compliant with the core of the PIDS standard. When our PIDS implementation is ready, the transition will be smoothly done. Besides that, the components produced are being introduced in the system as they are being created. This happened, for example, with the phonetic component, which is being used not as a distributed object, but as a simple component embedded in the system. This approach permits the introduction of a culture of utilization of standards in distributed objects and components. This cultural background will be fundamental in the future, when we do the transition to a fully distributed objects architecture**.**

Conclusions and Perspectives

The CorbaLab team is currently working on the pilot project. Some independent components are fully implemented and we began to work for making them easily available in the whole hospital.

Using software components in the development of systems give us many benefits: high level of concurrency in the development process, smaller number of errors, reuse of code, easier codification, testing and maintenance, and flexibility. However, building software components are not enough to gain the benefits possible with this technology. To really achieve a productivity breakthrough, it is necessary to pay attention in some design issues. First, it is necessary to reuse not only software code, but also reuse software models. As only few people are really experienced object-oriented designers, reusing well done designs in similar problems is fundamental to produce good software components. In the CorbaLab Project, all our models are well documented to allow different developers with similar problems to use the same design solution. This way, we intend, in the long term, to have an extensive library of healthcare design patterns. Second, the components have to be designed for reuse. Third, it is necessary to have an easily searchable repository of software components. This would allow developers to find easily the components that solve their problems, avoiding redundant implementations. This repository is a not solved issue in the CorbaLab project. We expect to work on it in the future. Finally, it is necessary to use standards that allow high level of interoperability among different applications, and because of that, we chose the CORBA standard.

In the process of introducing distributed objects in our hospital, we have to deal with a number of difficulties. The biggest difficulty is changing minds. Many an effort in the CorbaLab project has been directed at making people believe and accept this new paradigm. The seminars, demonstrations and courses we make have the objective of teaching

a new way of thinking and, until now, we have been successful.

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