# WEB PLATFORM TO SUPPORT THE SHARE AND REMOTE ACCESS TO MEDICAL IMAGES

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Abstract: The production of digital medical images has been growing in every healthcare institution, representing nowadays one the most valuable tools supporting the medical decision process and treatment procedures. One of the most important advantages of these digital systems is to simplify the widespread sharing and remote access of medical data between healthcare institutions. However, due to security and performance issues, the usage of these software packages has been restricted to Intranets. In general, the storage and transmission of digital medical image is based on the international DICOM standard and PACS systems. This paper analyses the traditional PACS communication limitations that contribute to their reduced usage in the Internet. It is also proposed an architecture, based on Webservices and encapsulation of DICOM objects in HTTP, to enable trans-institutional medical data transfers.

## 1 INTRODUCTION

It is widely known the enormous importance that IT technologies have been acquiring in all sectors, and the health services field is not immune to that reality. Effectively, a vanguard clinical service, properly equipped to administrate medical care in quantity and, most of all, in quality, cannot neglect a proper investment in IT, i.e. "in information systems and telematic infra-structures capable of assuring a set of activities related to medical care".

Along with the evolution of the information systems, it also grows the medical applications needs of computational processing, i.e. the management of patient demographics, as well as all the inherent process of diagnostic and/or medical intervention (acquisition, processing, transmission and storage). It is here that utilization of the most advanced multimedia technologies enters, making perfectly viable the co-existence of text elements and digital information that characterizes medical images formats. The main idea will be, therefore, to improve the acquisition, processing, transmission and storage of medical images, making trustworthy the diagnosis, improve the staff motivation, and still achieve a reduction in global costs.

## 2 DICOM STANDARD AND PACS SYSTEMS

With the increase in the use of electronic medical equipments and consequent amount of digital information, was necessary to develop a set of recommendations and base lines responsible for the inter-operability of medical equipment provided by different suppliers. It became essential the creation and adoption of a series of standards such as the DICOM (Digital Imaging and Communications in Medicine), developed by the consortium ACR-NEMA. It broadly defines the formats and processes of storage and transmission in medical imaging. Moreover, it not only promoted the data communication but also the development and expansion of the storage systems, converging to hardware and software platforms usually designated as PACS (Picture Archiving and Communication Systems) (Huang, 2004). Finally, it also defines



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interfaces with other medical information systems, namely RIS (Radiology Information Systems) and HIS (Healthcare Information Systems).

As a summary, we can say that DICOM protocol covers the following aspects (Philips, 1997):

- the commands syntax and associated data, so different devices can communicate;
- the file service syntax with respect to format and directory structure necessary;
- the operations in networked environments using, the existing standards (TCP/IP, …);
- support for new emerging services resulting from new medical image applications.

DICOM is now a well established standard in the medical community. Its global and versatile characteristics provide the interoperability of systems (modality equipments and information systems) in heterogeneous environments, featuring a variety of conformity levels.

The PACS concept encompasses several technologies including hardware and software for acquisition, distribution, storage and review of digital images on networked environments. There are several benefits associated with this technology are:

- unnecessary physical storage mechanism;
- permanent storage, without quality degradation;
- digital image processing;
- augment of clinical quality information.

PACS offers, to clinical staff, one technological environment that endows them with the possibility to remotely access the desired information. This system makes possible inter-institutional services such as image based telemedicine.

# 3 DICOM ARCHITECTURE ISSUES

PACS-DICOM architecture may now be considered as a key component in the health care sector. It is commonly recognized that the data access and distribution time can be drastically reduced (inter or intra-institutional), making the image data available immediately after procedure accomplishment.

In the last decade the sharing of data inside the institution local-area networks (LAN) (controlled environments) brings no problems. However, when we want to promote the remote access to the PACS from any part of the world, through the Internet, great barriers appear. In fact, the security measures implemented by institution network administrators, which usually grant access exclusively to the HTTP protocol, blocking all other connections, are limiting the usage of this architecture on an inter-institutional basis. Consequently, two major usage scenarios are compromised:

- Outsource of fully digital image services are difficult to deploy;
- Cooperative work among the healthcare professionals cannot be performed.

To cope with this issues, the norm recently added support the encapsulation of DICOM objects through HTTP (DICOM-P18, 2004), attempting to overcome the limitations indicated above.

# 4 ARCHITECTURE PROPOSAL

A healthcare institution is composed by several departments like, for instance, radiology and cardiology ( v.g: Figure 1). In what concerns the IT infra-structure, each one can have several PACS servers to store their medical images which can be accessed by dedicated workstations all connected through network DICOM protocol (over TCP/IP).

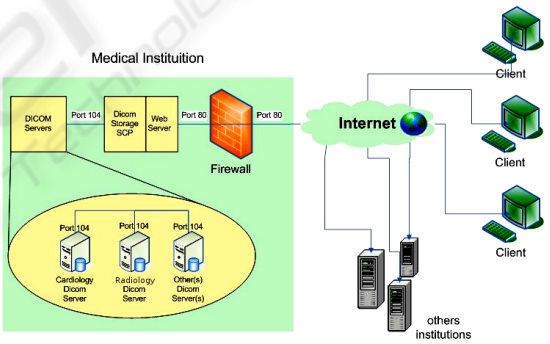


Figure 1: Architecture Implemented.

Normally, these servers can communicate between them and with the institutional public web-server, which is protected from the outside world by a firewall that only allows HTTP protocol traffic. Objecting an unrestricted mobility of image data, our approach uses the new DICOM 18 part standard, denominated as WADO (Web Access to DICOM Persistent Objects), to implement a Web based platform capable of supporting external access to a "firewalled" PACS. Moreover, the proposed solution makes possible to interact with several internal PACS servers from any outside point.

The developed platform contemplates two operation modes:

- visualization mode: search (by name, study date, type of study, etc) and listing all the patients registered in the system;
- reception mode: select a registered (internal) PACS server and remotely upload some studies, since the system configuration and security policies allows that.

In Figure 2 is shown a diagram of the supported processes by our platform. It is also possible to observe the workflow for each functionality.

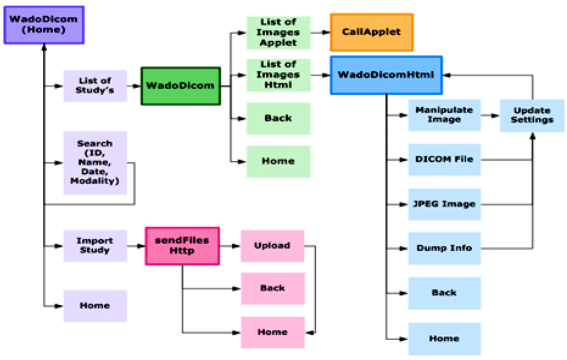


Figure 2: Processes Diagram.

The proposed solution is based on webservices technology and, consequently, the access to available DICOM services is done defining (in the URL) all the fields' necessary for that purpose. The DICOM norm (part 18) defines the parameters to support that service request:

- requestType: the value should be WADO;
- studyUID, seriesUID, objectUID: values that explicit one object, of a specific series of studies;
- contentType: mime type(s) desired by the web client for the response of the server;
- annotation: write patient information on the retrieved image;
- anonymize: removal of all patient identification information from within the DICOM object.

http://dicomproject.ieeta.pt/WadoDicom?requestType=WADO&studyUID=1.2.250.1.59.40211.12345678.678910&seriesUID=1.2.250.1.59.40211.789001276.14556172.67789&1.2.250.1.59.40211.2678810.87991027.899772.2&contentType=application%2Fdicom&anonymize=yes

In the above example an image is requested for a specific patient using UID's (identifier). The image format requested is DICOM (defined by the contentType field), without any patient identification information.

# 5 IMPLEMENTED SOLUTION

The solution deployment leads us to create a set of software modules to support the proposed services.

The visualization of image information in a given study is also possible. Because presently web browsers do not have native capacity for processing and viewing images in DICOM format, it was necessary to develop a specific viewer. To simplify the web browser integration, it was chosen to develop the viewer module in Java, as an Applet that runs on the client side workstation.

At this moment, the DICOM viewer (Figure 3) allows basic image manipulation (brightness, contrast, zoom, etc.), and also the visualization of dynamic medical image sequences (i.e. films).

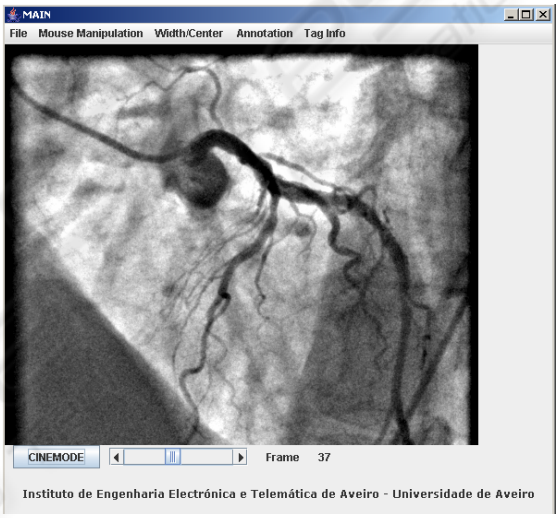


Figure 3: DICOM Image Viewer (Applet).

In reception mode, the platform allows the upload of external studies to a selectable internal PACS storage server. The exams services outsourced to a private entity can be received in this way. In every internal PACS server it was necessary to create a new "organizational instance" to separate the incoming studies from the other studies produced inside the department/institution.

The upload service is an extra functionality, not specified in the DICOM-WADO standard. However, its implementation has been pertinent, enabling one scenario of extreme importance to the healthcare units.

At this moment, we are studying strategies to implement transmission with data compression. In fact, there are some medical image modalities with high requirements of bandwidth to transmit the information with acceptable temporal costs. Namely, cardiologic modalities like the XA or the US.

### 5.1 Aspects of Software and Network Engineering

This platform was mainly developed with JAVA technology. The server's units were implemented as Servlets (Hall, 2003) and the clients as Applet (Prokhorenko).

The WadoClass is the critical module of this platform, because it contains methods and data structures necessary to interact with all the servers.

Some servlet-modules were created to work as interface between the client browser and the WadoClass (Figure 4). The manipulation of DICOM objects was handled with the help of PixelMed Java DICOM Toolkit (Clunie, 2006).

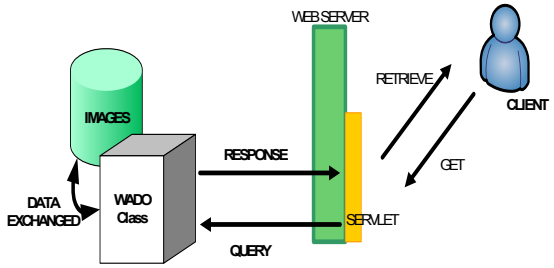


Figure 4: Interface between client and storage server.

Concerning the communications protocol layer (Figure 5), all the interactions between the client and the institution's portal (i.e. the WebService) are WADO based, i.e. DICOM objects encapsulated in HTTP protocol. The communications between the WebService and PACS servers are implemented with the conventional DICOM network protocol.

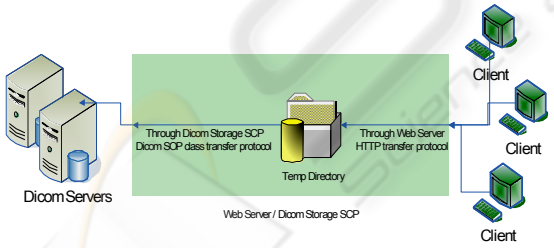


Figure 5: Data communications protocol.

Aiming to implement a scalable and easily reconfigurable solution, a configuration "WEB.XML" file was used. It allows the storage of several definitions, necessary for image communication inside the clinical institution.

## 6 CONCLUSIONS

Aiming the trans-institutional sharing and remote access to image patient information, we developed a platform that encapsulates DICOM objects in the HTTP protocol, providing a transparent integration with the traditional departmental of PACS-DICOM infra-structures. With the actual solution it is possible to promote, in a secure way, the remote access to departmental medical images and the upload of exams produced outside institution.

The paper focus has been on the description of the overall architecture, since the complexity of several and important components, namely the DICOM objects manipulation, cannot be clearly presented just in the scope of this paper.

The overall result is a cost-effective system with reduced computational requirements, making possible its deployment in any existent web server of any healthcare institution.

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