EuroStore mass storage Project in the medical environment

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Abstract

In the framework of the EuroStore* project to build a mass storage system, the TERA Collaboration designed the Medical Image Storage System (MISS) for the centralized data management of radiological hospital wards and beyond.
MISS allows for the management of medical images inside a hospital center and can be used for the organization of the data of an entire radiological ward. It handles storage and retrieval of clinical information (data and images) received from a remote machine (a medical data acquisition device called a modality). A physician or nurse accesses the system through a graphical Web interface.
Expensive archive systems (such as the PACS) are available today in many hospitals, but unlike MISS, they do not allow for the management of data from multiple radiological hospital wards.
The outcome of this project that heavily draws on HEP technology and expertise will be commercialized, for use on a regional or national scale. Around MISS secure storage and retrieval of medical data services will be organized specifically for medical institutions. These services will be fast and offered at a reasonable price.

Keywords: mass storage, medical informatics

1 Introduction

The TERA Collaboration has been an associate partner to CERN in the role of a user for the medical exploitation of the results of EuroStore [1] (see http://www.cern.ch/eurostore/). The TERA groups working in Genova, Novara and Geneva, designed the Medical Image Storage System (**MISS**) for the centralized data management of radiological hospital wards and beyond.

By having implemented MISS, TERA has identified the key points for the exploitation of the EuroStore prototype inside a hospital center. MISS can be used for the organization of the data of an entire radiological ward. It handles storage and retrieval of clinical information (data and images) received from a remote machine (a medical data acquisition device called a modality). A physician or nurse accesses the system through a graphical Web interface. Whereas expensive archive systems (such as the PACS) are available today in many hospitals, unlike MISS they do not allow for the management of data from multiple radiological hospital wards and don't solve problems related to the storage of media produced (up to tens of optical disks every day).

Relevant aspects of the study of this service will involve planning for the required bandwidth because a high number of clients will be able to access this data server with a limited bandwidth.

Local governments and regional authorities will have the technology that will allow them to organise the services related to storage in the terms required by the latest legislation (i.e. guaranteeing the persistence of the data for a legally agreed period of time).

2 Description of the MISS Prototype

The MISS system is able to store clinical information (data and images) received from a remote machine (Modalities and Workstations) using a network connection, and give access to a medical end user through a simple graphical interface developed using Web client/server technologies.

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The connection between MISS and the medical environment requires a specific network interface that conforms to the DICOM 3.0 standard. For this reason the system implements the basics DICOM networking services for image storage and retrieval. These application-level services allow the transmission of DICOM images between any DICOM compliant modality and the TERA storage system (MISS) connected to EuroStore.

The architecture of the prototype is shown in Figure 1. The platform chosen for the MISS prototype is a Personal Computer with the Microsoft Windows NT Server 4.0 operating system. In the following every module is described in details specifying the basic activities for the development phase.

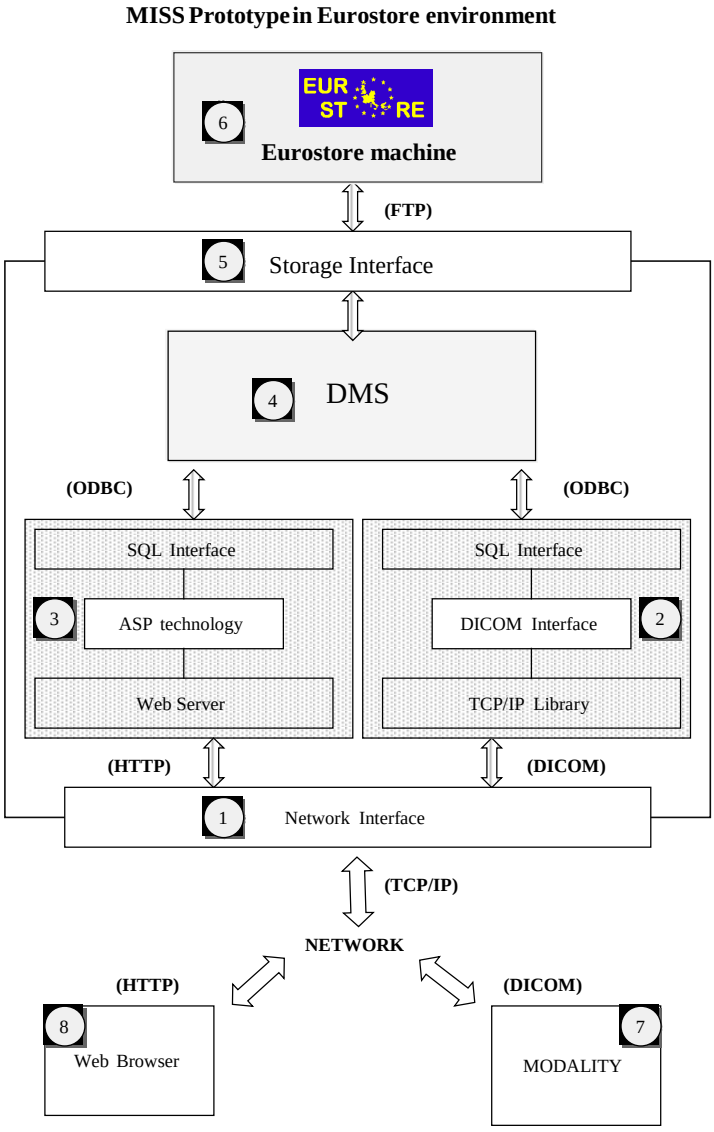

Figure1: MISS Prototype Architecture

Modules of the MISS system:

1. **Network Interface**: This module allows data exchange between MISS system and remote machines. The Network interface can be connected to a Local Area Network or to a Wide Area Network (Internet/Intranet). Network connections are allowed only with authorized machines, using secure network channels.
2. **Dicom Interface**: This software module implements the Dicom 3.0 network protocol that allows for reception of the connections from authorized remote applications for image storage requests. It grants exchange of Dicom messages among Miss system and remote

DICOM machines. Data about connections from remote Dicom applications are saved in a log file.

3. **User Interface Manager**: This module allows authorized users to connect from a remote machine to the MISS system and retrieve the information stored in the archive. Users can consult clinical data using a Web Browser or eventually a specific client application. The functionalities implemented in the user interface depend on the privileges of the user. User's connections and operations are saved on a log file for security reasons.
4. **Data Management System (DMS)**: This is the core of the MISS system; clinical information is stored and retrieved by the DMS module which gives access to the MISS interfaces and controls data exchange with the storage system. It implements the MISS Information Model that describes the organization of clinical information, structured according to the system requirements. DMS writes a log file with the transactions performed in data management. The resource chosen to realise DMS is the Microsoft relational database (RDBMS) MSSQL version 6.5.
5. **Storage Interface**: The storage interface allows data exchange between the DMS and the storage system, in our case the EuroStore system; it gives the basic services to the DMS module to store and retrieve data from a physical device. The implementation of this module depends on the particular storage system used. Storage/retrieve operations are written on a log file for security reasons.
6. **Storage System**: The task of this module is to read and write data on the physical devices without any limitation about file dimensions. The storage module organizes different storage levels and manages the data migration between them. Different kinds of storage systems affects MISS with the implementation of new storage interfaces.

Modules connected to the MISS system (external): the features of these modules are described in order to specify the functionalities supported by MISS

7. **Modality**: This is an external module connected through a network to the MISS system. The types of modalities supported are Computer Tomography, Magnetic Resonance, Computer Radiography; every modality sends Dicom compliant images, using the Dicom network protocol, to the MISS Dicom interface.

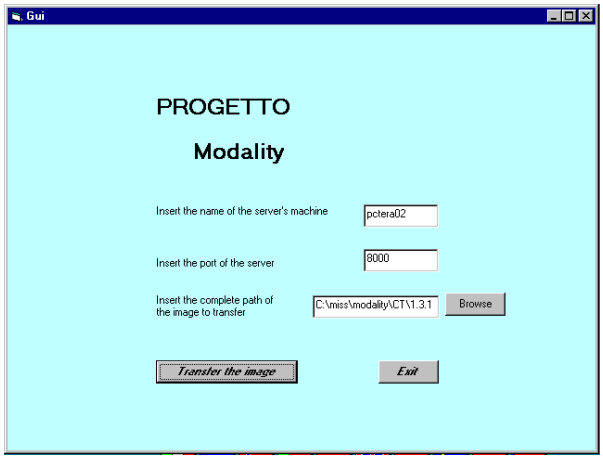

Figure 2: Modality is the interface to DICOM files

8. **MISS Client**: The task of this external module is to allow users to log on the MISS system, to retrieve clinical information and to perform administration tasks on the archive depending on their privileges. Client software is connected to the User Interface Manager through the network and implements the Graphical User Interface displaying data on the screen of the client station.
   In order to gain portability, Web technologies are used:
   I. Data viewer: WWW browsers like Netscape Navigator or Internet Explorer.
   II. Image viewer. Two solutions are possible: either a Helper application, i.e. an application associated with image extension that is run by the browser or AciveX control: a technology that lets the image to be displayed within the browser.

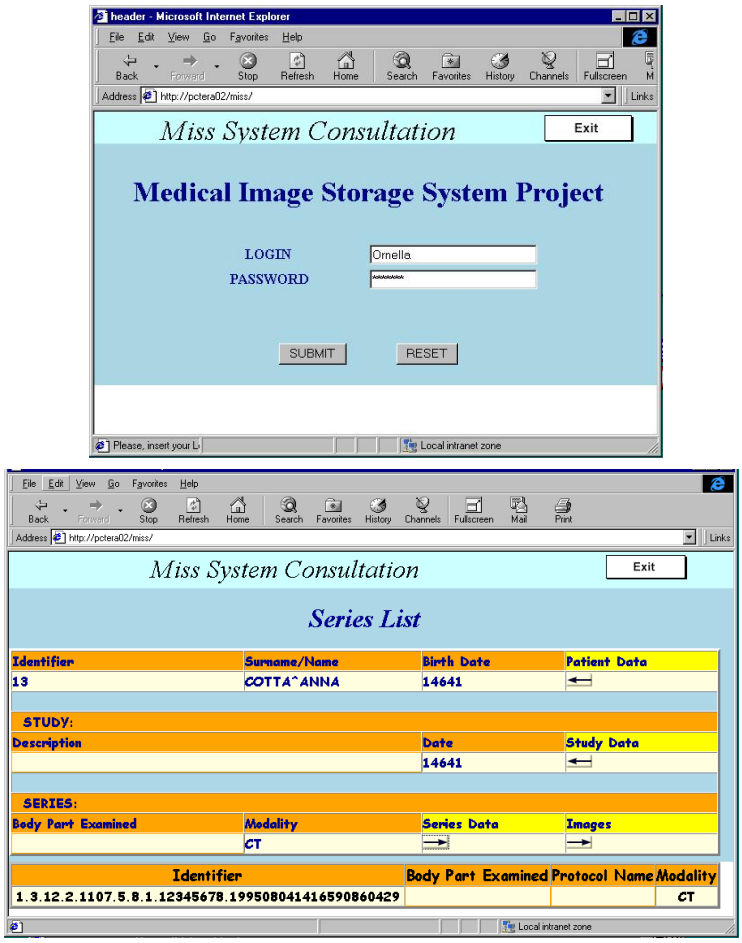

Figure 3: The database defines tables for: Patient, Study, Series, Image, Modality, User.

3 Status of MISS

A first implementation of the system is operational and tests of the system, connected to the EuroStore prototype at CERN, will be conducted in March 2000. Future developments with Linux as platform, Oracle™ as DBMS and XML or HL7 as data model are foreseen if a second phase of the Project will be approved.

4 Conclusions

MISS is the first system that exploits the technology developed by EuroStore. The high storage requirements of modern and future medical centers, integrated over the coming few years, are important. Despite the presence of the DICOM standard however, the different technologies risk to generate decentralized and incompatible data.

MISS has the advantage that every user disposes of a “high end” service without having to worry about the implementation, maintenance and compatibility issues of a storage center.

This is very attractive for medical centers that have to invest high sums of money for the storage needs of incompatible data generating systems. Data can now flow automatically (on request) from the producer to the consumer (e.g. from radiology to radiotherapy, oncology or surgery) via the centralized storage system. TERA plans to implement the EuroStore service guaranteeing maintenance of software, hardware and privacy.

5 References

1 I. Augustin, "Test Results of the EuroStore Mass Storage System", CHEP2000, Padova.