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Prototype of a JAVA/DICOM Image Server with Integrated Findings and Data Security

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Abstract. The transfer of medical data within heterogeneous hard- and software infrastructures requires platform-independent standardized protocols and data formats such as DICOM. To avoid costly vendor-specific solutions a DICOM server was implemented in JAVA thereby enabling the data access via internet browser technology. The most important patient and image acquisition information were extracted from the DICOM images and stored into a relational database. For an integrated view patient information such as radiological findings were transferred from the Radiological Information System (RIS) into the data base. Image data were accessed either by a fast preview tool or using a DICOM viewer. Since DICOM does not include inherent data security mechanisms, a second tool allowed the DICOM-conform encryption of DCIOM data for a secure long term storage on CD-R or across unsecure networks.

1. Introduction

More and more hospital infrastructures include high-performance networks. Mostly triggered by the need of hospital information systems (HIS), the networks may also provide image data transfer between different departments. Depending on the network capacity huge data amounts can be transferred in a short time, which is required for a high compliance of the medical users. The most often encountered problems for a data transfer include historically grown heterogeneous hard- and software infrastructures, the difficulty of providing a unified access to data, the costly dependence of long term data storage from vendor specific solutions, and changing demands of the medical users that require the adaptation of data server capabilities.
For a standardized exchange of image data the DICOM standard [1-3] offers the highest potential. To achieve platform-independence and to provide an economic and unified access to patient and image data the software was implemented in Java. For long term storage low cost CD-R were used. However, DICOM has the disadvantage of a lack of standardized security mechanisms. Therefore, we added a software module to the server that enabled a DICOM-conform encryption of the data [4-6].

2. Methods and results

The DICOM server was installed in the department of Radiology and Nuclear Medicine. Hardware platform was a dual processor PC (Intel, 400 MHz, 256 MB RAM, 13 GB HD).

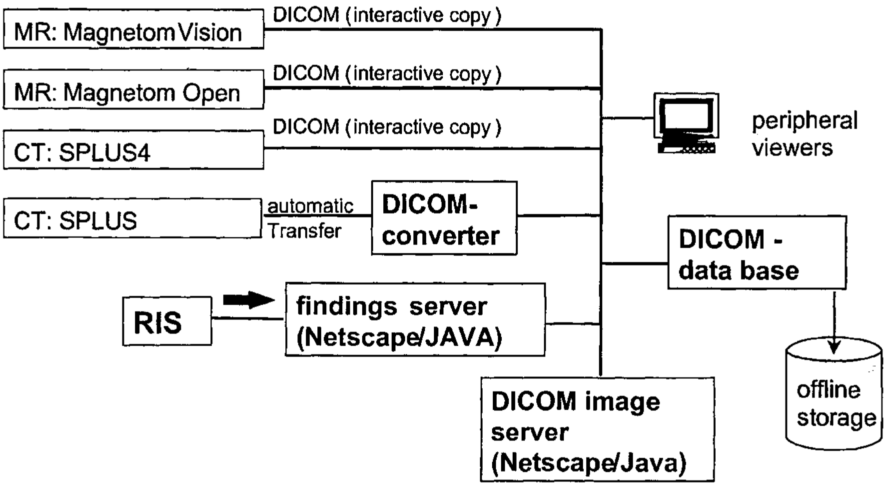

Figure 1: Scheme of the infrastructure. For details see text.

As operating system Windows NT 4.0 was used. Four DICOM modalities (2 MR scanners and 2 CT) were connected to the server (Fig. 1). Since one of the CT scanners did not provide DICOM images, a software tool had to be developed to convert original data into DICOM. Proprietary image data were accessed and transferred automatically using a self-developed macro (Pathworks Version 6.0). The conversion software was written in C and also installed under Windows NT 4.0. The relational database (Sybase SQL Anywhere Studio 6.0.3) was accessed via middleware (Symantec dbAnywhere Version 1.1a). The DICOM server was implemented in Java (SUN JDK 1.1.7B).
Selected patient data such as name, birth date, ID-number as well as radiological findings were transferred via an interface from the RIS. This allowed to correlate findings with images and to include additional information such as the requesting department. For viewers outside the radiological department findings could only be viewed if labeled as final. Furthermore external viewers had only access to data if either the examinations were initiated by the requesting department, if the patient was transferred from another department and now treated by the requesting department, or if an emergency override was permitted. Figure 2 shows the GUI of the findings server.
To reduce the network load viewers could preview compressed images that were stored as GIF icons in the data base. Selected icons could then either be magnified or the corresponding original DICOM images could be transferred to the DICOM viewer (Fig. 3). All user interfaces were realized as JAVA applications. Image data were deleted after 5 days. Findings were kept to allow to trace the patients clinical history. Stored image data were marked as stored (with reference to store CD-R) and then deleted from the harddisk.
For DICOM conform data encryption a new concept was developed that enabled a high speed secure data transfer. Selected data were encrypted and either transferred to another computer or stored on a CD-R as described in more detail in [6, 7]. The basic problem to be overcome on encrypting DICOM images is the fact, that the DICOM structure contains fields that have to be filled in a standardized way. E.g., name or birth date may neither be filled with special symbols created by encryption algorithms nor may be left empty. Our proposed solution is to fill patient-relevant fields with allowed but meaningless information, to encrypt the original information and put it into so-called private groups.

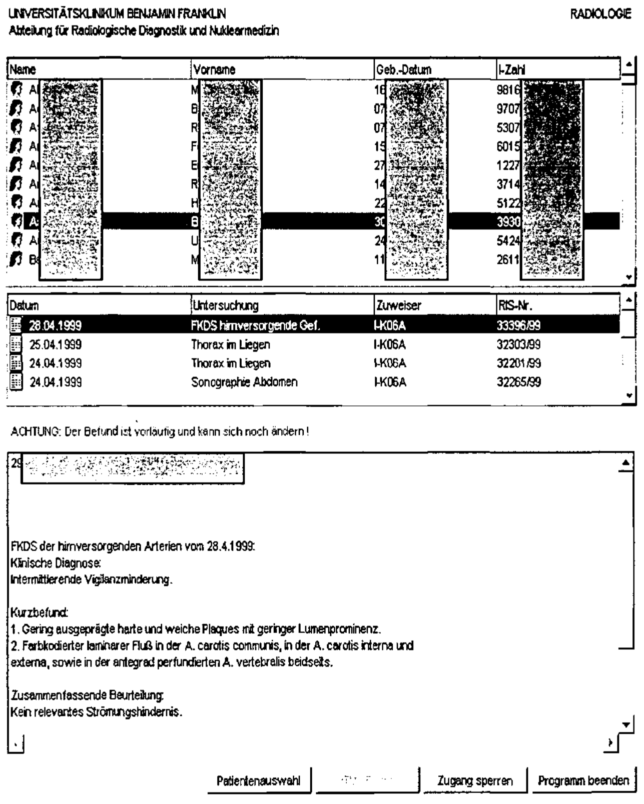

Figure 2: JAVA-based access to the findings server. For easy and intuitive use medical users connect to the server via a bookmark in the internet browser. After inserting the department ID and the password, different selections of patients can be viewed. For details see text.

The rather complicated details and the comparison with other security concepts are described in more detail in [5-7].

The findings server is now used in the clinical routine for about two years without any problems. The image server passed first tests successfully and is recently in the evaluation phase. It will be introduced into the clinic during the year. More patients findings such as laboratory data and neurological findings will be included into the data base.

3. Discussion and future work

DICOM servers that were realized platform-independently using Java have been described [8-10]. However, the presented concept is based on a different strategy: The inclusion of radiological findings is the first step towards a Java-based dynamical patient record. Main goal is to enable different medical users to build different medical records adapted to their medical needs. While one doctor may include lots of images but few non-image data another doctor, perhaps at a later time, may choose to build a patient record using only few

selected images but more non-image information such as laboratory data or other findings. The DICOM structure allows also to include DICOM-conform video sequences as provided by laparoscopy or ultrasound [11]. This opens the way for a more sophisticated multimedia applications such as including the sound of velocity-encoded Doppler ultra sound. The complex structure of a patient record may also be implemented within the DICOM concept of structured reporting [1], which will enable to exchange complex patient dependent information directly between different DICOM modalities instead of using additional intermediate data bases.
Within our project the concept has proven to receive a high compliance of the clinical users which is the base for acceptance and usage of any medical information system. One of the main points for the acceptance was the easy use of the GUI as well as the economic installation since in most cases no additional hard- or software was required. Usual PC with internet browsers were available in almost each of the departments. The central implementation has the advantage that changes had to be implemented only in one place which is very important to guarantee a consistent software status. The use of the internet technology offers also the chance to apply telemedical applications. Corresponding security considerations have been described in more detail previously [5,7]. They may be divided in protocol-based security mechanisms such as Secure Socket Layer (SSL) or encryption of the data structures. Protocol-based security as recently proposed by the DICOM security working group has the advantage that large changes in the already very extended DICOM standard are not necessary. Their disadvantage is the lack of flexibility, since only those computers can participate that have installed secure protocols. Furthermore, no security check is provided on the application side. Our concept however enables a secure transfer of DICOM data. Within the concept the application can allow a restricted acces for semi-authorized users, e.g., that have to post-process image data as for 3D rendering but are not allowed to decrypt and view patient-relevant information.

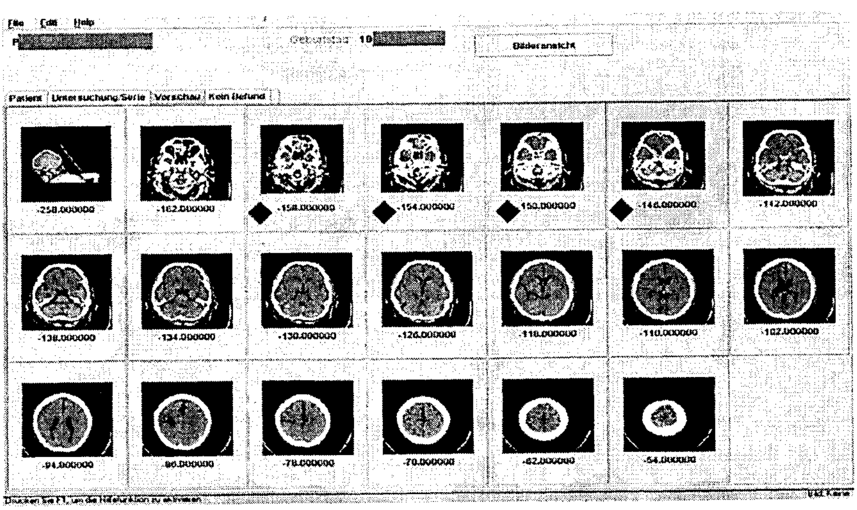

Figure 3: JAVA-based preview of GIF images of a selected study. Network load is further reduced by transferring only selected images (marked with diamonds on the icons) to the DICOM viewer.

As a second advantage our concept allows the secure storage of the encrypted data on CD which can not be realized with protocol-based security concepts. Since an economic storage of image data requires usually the storage on optical discs our concept provides an efficient low-cost way for a secure data storage.

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