

# Real World PACS for Radiology

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**BACKGROUND:** *The main objective was to implement PACS (Picture Archiving and Communication System) in the real world environment of Radiology department of Military Medical Academy in Belgrade, consisting of heterogeneous radiology equipment of different generations and various suppliers, while keeping the costs at acceptable level. It was essential to maintain the system capability for upgrades from different sources and to provide connectivity options to other systems inside and outside of the hospital.*

**MATERIAL AND METHODS:** *In order to achieve maximum flexibility at minimal cost it was decided to use "off the shelf" hardware and software components and to keep conformance with widely accepted international and "de facto" industry standards. Extensive engineering and software development, and interactive relations with customer were the characteristics of the project, from the phase of its definition all through its realization and testing. The images are acquired with frame grabber PCI cards. The workstations are standard PCs with Windows OS. The workstation software includes DICOM output module, image processing and manipulation module, voice recording module and diagnostic modules. Archiving of the images can be realized locally or on the central server.*

**RESULTS:** *The realized system consists of one PC workstation for patient admittance, doctor workstations, one acquisition station and 3 viewing workstations for Shimatzu IDR1000s, and workstations for Acuson US image acquisition. Images can be acquired in single mode (up to 4000x4000, 12 bit) or multi image real-time mode (30 frames/sec and 1024x1024 resolution). The application includes a set of image manipulation functions, DICOM module for distribution of images and voice recording module for radiological diagnosis. Display layouts, option menus and report layouts are customized according to user's specifications.*

**CONCLUSION:** *Described Radiology PACS system has been in everyday operational use for one year. It is planned to expand the system by adding of new modalities such as CT and MRI, to be connected to radiotherapy network, and development of speech recognition software module and introduction of central patient and image server.*

**KEY WORDS:** *PACS; DICOM; Computer assisted radiology; Medical imaging; Image processing*

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## INTRODUCTION

The main objective was to implement PACS (Picture Archiving and Communication System) in the real world environment of Radiology department of Military Medical Academy in Belgrade, consisting of heterogeneous radiology equipment of different generations and various suppliers, while keeping the costs at acceptable level. Number of digital and DICOM compatible X-ray diagnostic equipment in our country is negligible compared to the esti-

mated installed base of more than 2500 analog units. Therefore it was necessary to provide image acquisition from analog sources. In order to ensure safe upgrade path in future these images have to be converted to DICOM compatible format, as a basic element of PACS. This also guarantees open connectivity to both local and wide area network level, providing a strong foundation for future telemedicine developments.

## MATERIAL AND METHODS

In order to achieve maximum flexibility at minimal cost it was decided to use "off the shelf" hardware and software components and to keep conformance with widely accepted international and "de facto" industry standards. Extensive engineering and software development and interactive relations with customer were the

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main characteristics of the project, from the phase of its definition all through its realization and testing.

The images are acquired with different frame grabbers depending on modality characteristics. The workstations are standard PCs with Windows OS. The workstation software includes DICOM output module, image processing and manipulation module, voice recording module and diagnostic modules. Archiving of the images can be realized locally or on the central server.

## RESULTS

The Realized system is depicted in Figure 1. It consists of one PC workstation for patient admittance, five workstations in doctor rooms, one acquisition station and three viewing PCs for images from Shimadzu IDR1000s one being DICOM server, and two workstations for Acusonic US image acquisition and viewing.

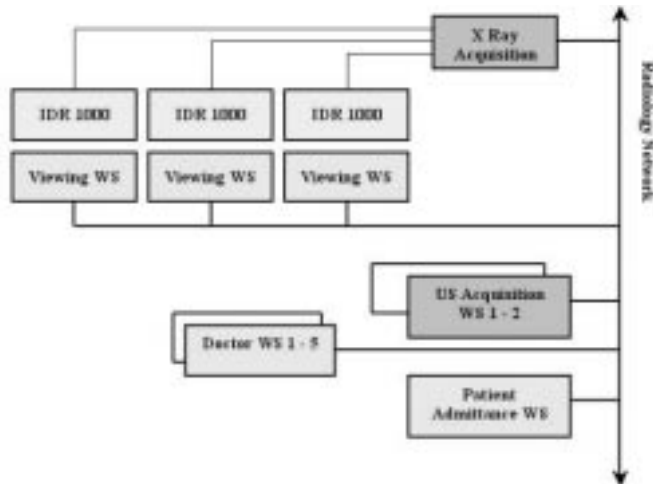


Figure 1. Block scheme of the PACS System

Hi\*DEF frame grabber cards from Foresight Imaging are used for image acquisition from different video sources. These are the only cards certified for radiology applications by American College of Radiology (ACR). Standard and high-resolution video signals with



Figure 2. Typical screen layout

frequency up to 150MHz can be acquired with these frame grabbers. Images can be acquired in single mode (up to 4000x4000, 12 bit) or multi image real time mode (30 frames/sec and 1024x1024 resolution).

For ultrasound image a range of lower performance frame grabber cards can be used. This solution is much cheaper than hardware and software upgrades for DICOM on the existing equipment, with the same and, in some cases, better image quality. At the same time flexibility of Windows environment opens a lot of possibilities in the sphere of image format conversion, storage, printing and transfer, normally not available or extra charged on upgraded systems.

Application includes a set of image manipulation functions: contrast windowing tool for continuous manipulation of gray-scale width and level, gray-scale inversion tool, zooming functions, image rotation and shifting, image copying and new study creation, filtering, image arithmetic, linear, angle and measurement functions and various format conversions. Some of the listed software features are illustrated on one of characteristic screens (Figure 2).

Voice recording module is used for storing and replaying radiological diagnosis.

Display layouts, option menus and report Layouts are customized according to user's specifications. Patient and image database is relational database based on SQL standard.

## CONCLUSION

Described Radiology PACS system has been in everyday operational use for one year, with full functionality and to customer satisfaction.

It is planned to expand the system by adding of new modalities such as CT and MR, to be connected to radiotherapy network, development of speech recognition software module and introduction of central patient and image server.

The realized PACS system is the first important step towards diverse teleradiology system implementations.

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