Conquest DICOM Server For Beginners!

Setting up A DICOM server with Conquest and MIPAV

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1. Introduction

Historically setting up a DICOM server for medical application was seen as a complex process and confuse the newbies. To change this scene, vast amount of attempts were exerted during past two decades. Consequently, a pile of free and open source software packages were developed all around the world. Thanks to this endeavors, now setting up a DICOM sever in a real environment is easy and cheap task even for beginners.

This document shows how to set up a simple conquest DICOM server and make connection to it through terminals. The objectives of this document are those who have no idea about computer networks, DICOM server and even medical image retrieval but want to set up a simple (and consequently rude) DICOM server.

To achieve above objective *Conquest DICOM server* is chosen. Conquest project started in 1998 and from that year on, till now 2014, regularly updated and debugged. A simple graphical user interface, small size (1.5 Mb), simplicity of use , sufficient documentation and support are reasons that made it one of the best *off-the-shelf* options for educational and small-size real applications.

Medical images have their own specific standard and file format[1]; so, opening and manipulating these files needs specific soft wares-- generally well-known as image viewer. In this document MIPAV is chosen. This software is not just a simple DICOM viewer but it also: supports different types of filtrations and analysis on images, is able to connect to DICOM server and finally, is dexterous image manipulator.

In the following first a bunch of words are redefined to clarify the picture. Then starting from downloading, step by step, we want to go through how to set up the softwares. Finally, by means of sample test image we put all stuffs into action.

[1] Usually dcm file extension refers to DICOM images.

2. Definitions and key words

Early in 1980 Digital Imaging and Communications in Medicine (DICOM) is developed to standardize the communication between different digital imaging devices. Before that time each manufacturer owned its own protocols and this made communication among different devices from different manufacturer's very difficult, if it were not impossible.

DICOM standard is comprehensive and includes almost every bit of digital communication in medicine. It also includes a definition for medical file format, well-known as DICOM file. Each DICOM file (usually with *dcm* file extension) is made up of two compartment: one for storing image(s) and the other one is meta data (like patient name, date of birth, device modality, etc) on images. (Figure 1-1)

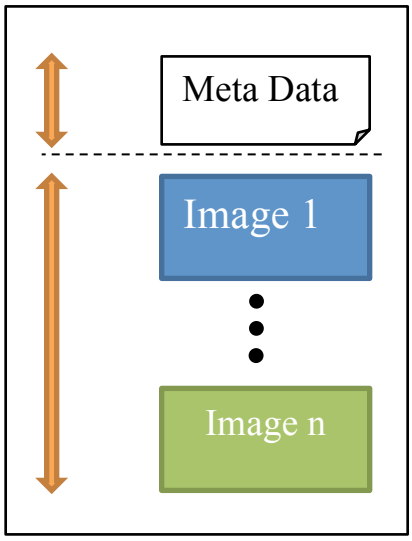

Figure 2-1 DICOM File Structure- each DICOM file made up of two sections

DICOM consortium instead of defining dedicated communication protocol decided to use TCP/IP protocol stack. In this protocol stack, each individual computer has a

unique address known as IP address[2]. An IP address locates a computer on a network. Intuitively, one can think of IP address as apartment number which locates the apartment's location on a street. But, each apartment may have many flats in it. To distinguish between them each flat has a dedicated *internal number*. In the network realm, a similar situation happens. Usually many different applications on each PC are running concurrently, to distinguish them from each other; another dedicated number is assigned to applications. This number is known as *port number* of that application.

For transferring data between two applications on a network, each application on both sides of channel not only has to know IP address of the other side but also they have to know port number. By means of IP address they can locate the other sides PC and by means of port number the process which is addressed is specifically determined.

A computer network is indeed a graph of nodes. Each node has a set of specific responsibilities; some are *end nodes* (like leaves of a graph), some are to *server* the other nodes and some are to make *interconnection* between servant and server.

End nodes produce data and send/receive the data into/from network. In network literature this nodes are named *clients*. On the other extremity, server nodes are responsible to serve the client with specific set of services. For example, consider a user that wants to upload a movie to a web site. The computer of this user would be a client and computer of the website which provides the uploading, saving and streaming of the videos would be a server. Usually, client and server are far apart from each other. To make the connection between them possible, set of nodes known as routing nodes exist. Technically they are coined *routers*.

In a not accurate language, DICOM servers are responsible to provide recoding and retrieving medical records to the clients. With regards to size of the hospital and work load, dozens of DICOM servers might be needed to collaborate with each other to fulfill the work load. DICOM consortium defined the concept of *application entity* (AE). It is a unique given name[3] to each DICOM server.

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[2] Current version of IP (IPv.4) consists of 4 part, each of which is a 3 digit number (ie. xxx.xxx.xxx.xxx)
[3] In string format

This naming convention is a major difference between TCP/IP networks and DICOM networks.

3. DICOM Networks

Before getting hands dirty with implementation, we have to mention some points which shine light on the future steps. As it is mentioned in the previous section, DICOM files made of two compartment, meta-data and images. Contents of the meta-data are in text format, while images are heavy trunk of bits. From computational perspective, the first one is easy to keep in databases (like SQL) while the other one is heavy and usually kept outside of databases. A general trend in database design is to put them inside a folder and accessing them directly from hard disc.

With regard to this point, in some DICOM architectures it is possible to keep meta-data in machine and image files on another machine. By this mean, load would be balanced and it would be easy to back up the data (Fig.3-1). However, for the purpose of simplicity in this document, we would keep images and data on a same machine.

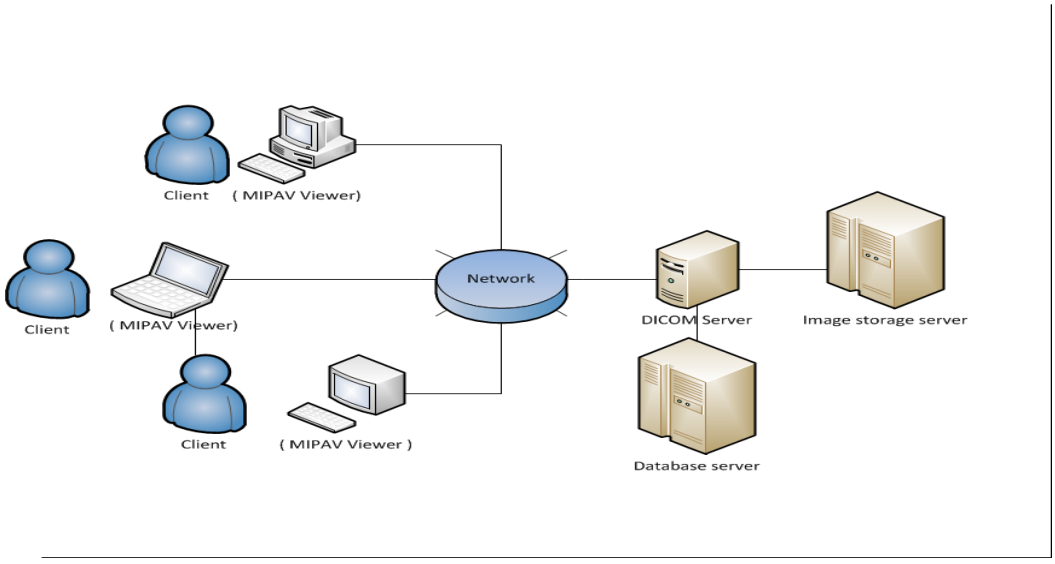


Figure 3-1 PACS Server. Image server and meta data may be kept separately

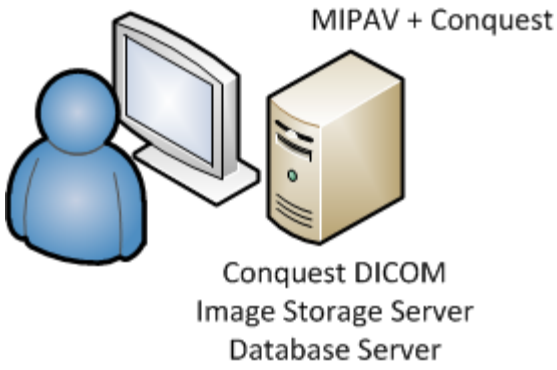


Figure 3-2 implemented system

4. Implementation

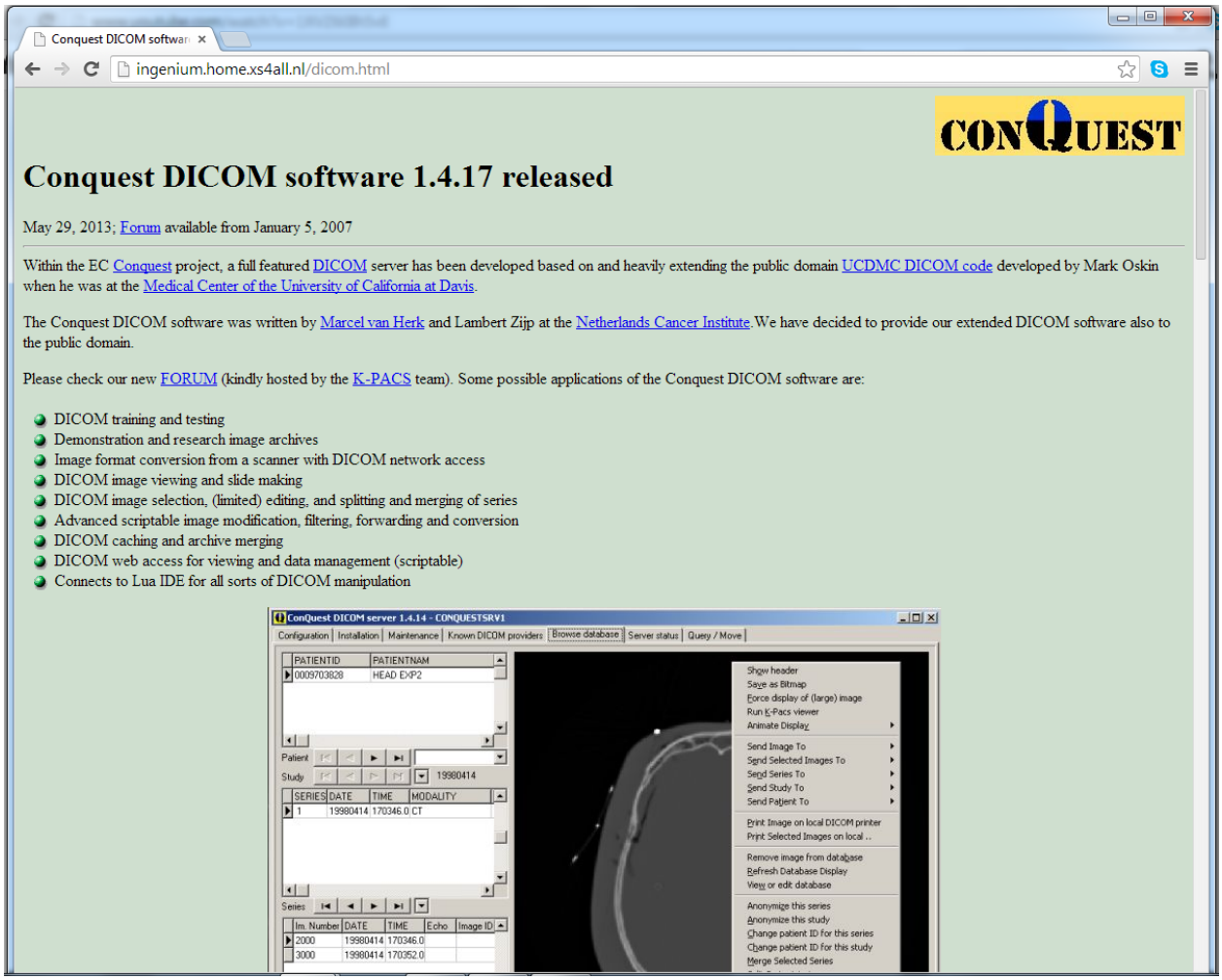
Downloading

The very first step is to download necessary software. Table 1 shows the complete list of downloaded software and a brief description[4].

Table 1 Software list

Software	Description	Location
Conquest DICOM Server	Serves incoming connections, save and retrieve images	http://ingenium.home.xs4all.nl/dicom.html
MIPAV	Connect to DICOM server, send/receive data, view and modify images	http://mipav.cit.nih.gov/clickwrap.php
DBFView	For monitoring how conquest saves data	http://www.dbfview.com/
DICOM sample images	For testing the final system	http://filmandpaperdigitizers.com/samples.htm

[4] All the links are tested at 2014



Download for Windows:

New features: [version 1417: Connects to ZeroBraneStudio IDE for Lua development] [version 1416: Built-in support for JPEG and JPEG2000; lua scripting] [version 1415: 64 bit; postgres; improved virtual server performance; jpg images possible in web interface; multiframe support in serversideviewer; sequence access in scripting; anonymizationscript; better handling of corrupt DICOM files;] [Version 1.4.14: New features: improved web pages and scripting, bug fixes; flexible import/export converters; Number of Study Related Instance queryable etc.] [Version 1.4.13: SqLite driver, jpeg and mysql driver in one package, auto setup database, delayed forwarders and prefetchers, more scripting commands, WEB viewer for IE, configure V2/DCM, configuration of deletion order, bug fixes. [Version 1.4.12c: Bug fixes, import converter, converter scripting, extensions to flexible filenamesyntax], [Version 1.4.12: better database performance, better control of forwarding, important bug fixes], [Version 1.4.11: K-Pacs viewer, native MySql driver, worklist fix, virtualserver fix, flexible filenamesyntax, WEBReadOnly, Fix forwarder retry logic], [version 1.4.10: Virtual server, Optional more debug info], [version 149a: GUI crash fix], [version 149: Modality Worklist, Linux and Web interface (fixes), faster retrieve, fixes in delete and nightly move, retry failed forwards, more JPEG fixes, built-in JPEG/RLE decompressor, downsize compressor, AE with ~xx sets compression, split/merge series, multiple UID query]

Download **dicomserver1417.zip** (10708 KB, Complete DICOM server + documentation + sample data + IDE integration)

Download **dgate1417.zip** (1943 KB, updated source code of the UCMDC/NKI DICOM server process, for windows)

Download **dicomlib1417.zip** (910 KB, updated source code of the UCMDC dicom library and sample client programs, for windows)

Figure 4-1 Downloading Conquest

Figure 4-2 Downloading MIPAV

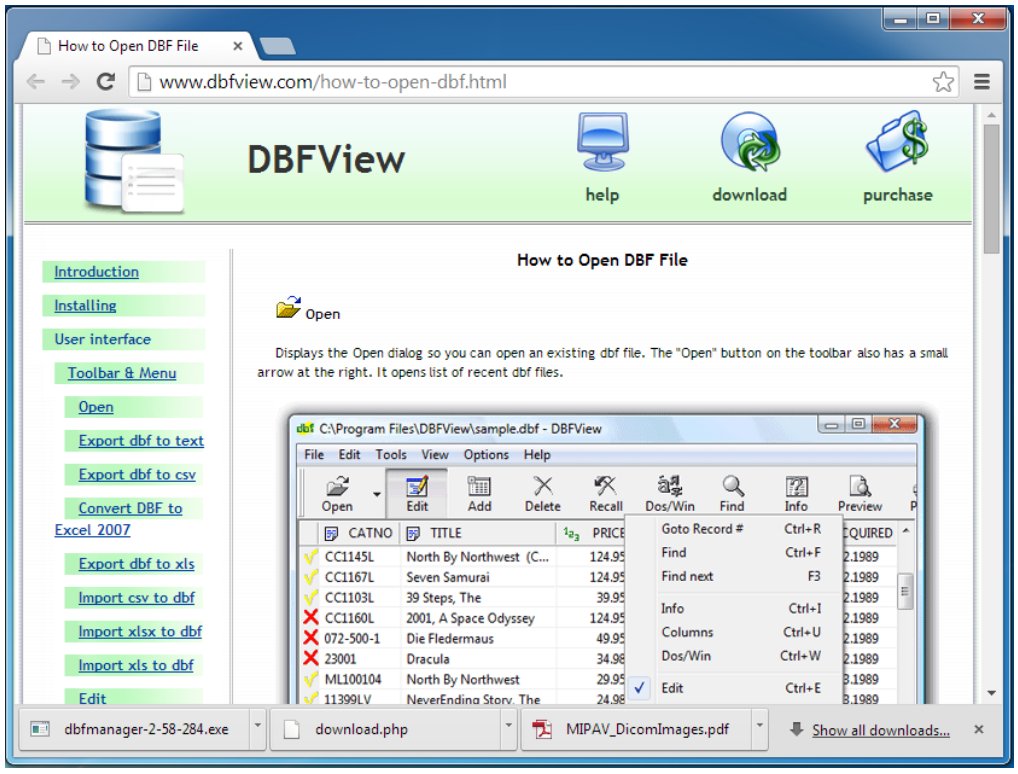


Figure 4-3 Downloding DFView

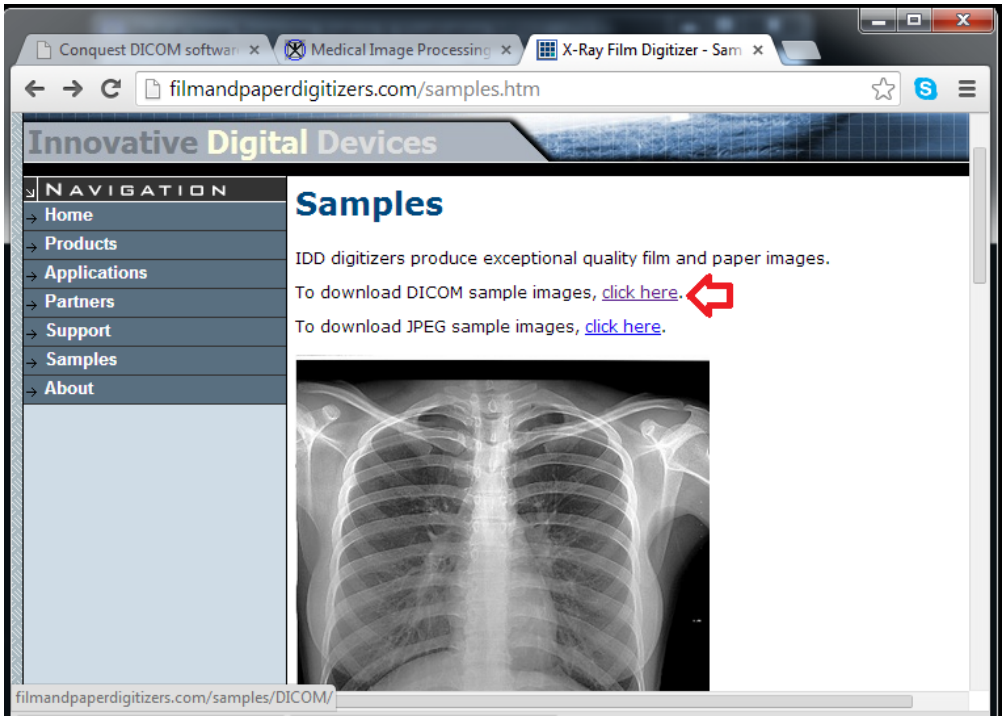


Figure 4-4 Downloading Sample Images

Setting up Conquest

After downloading and extracting Conquest, ConquestDicomServer should be started.

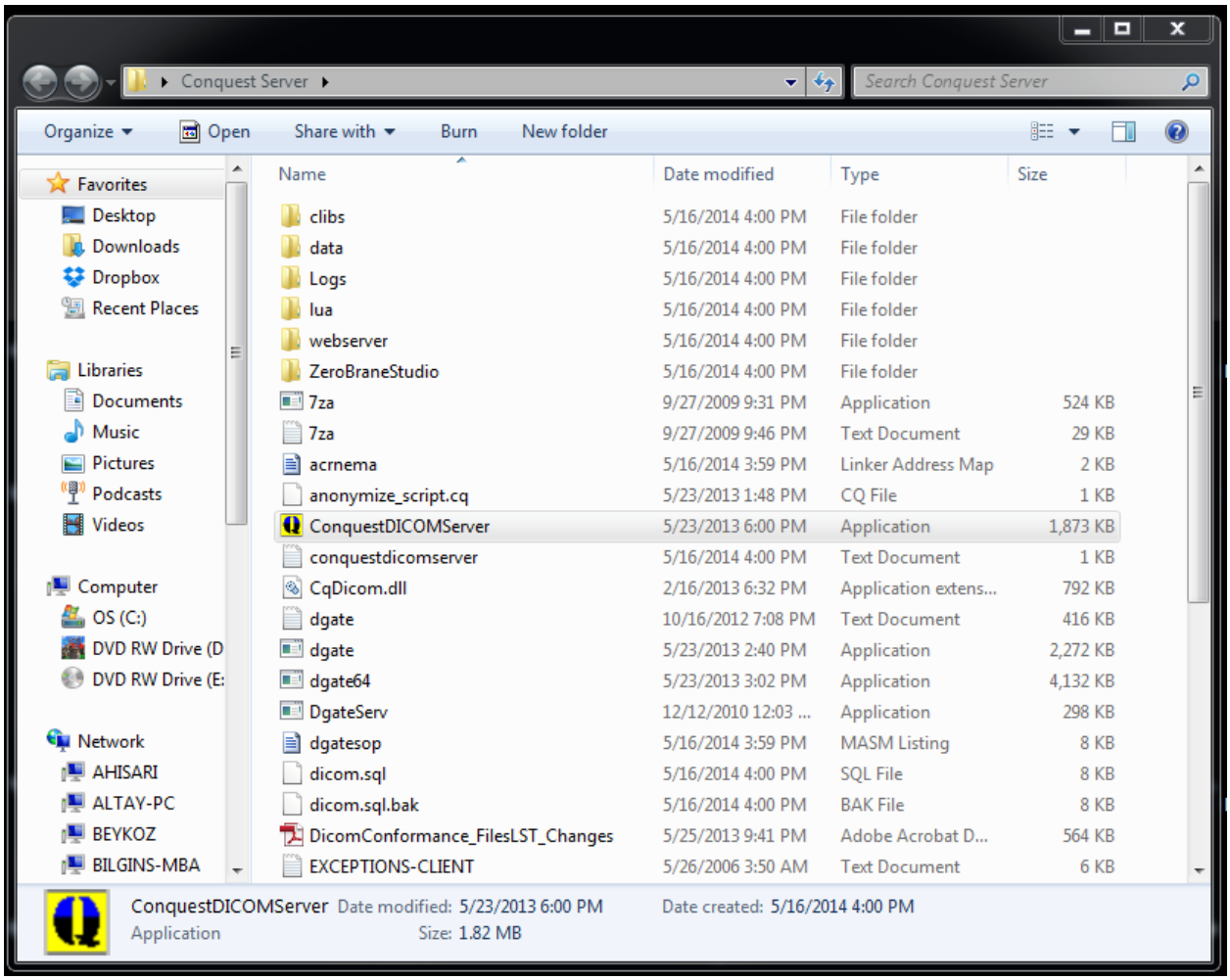


Figure 4-5 Starting Conquest DICOM Server.

Conquest DICOM server supports different types of databases. For the first time, the user will be asked to choose among different options. Based on conquest's documentations built in SQL-lite is simplest option for beginners so we will continue with this option too. In the case of more interest, the reader is referred to the conquest documentation.

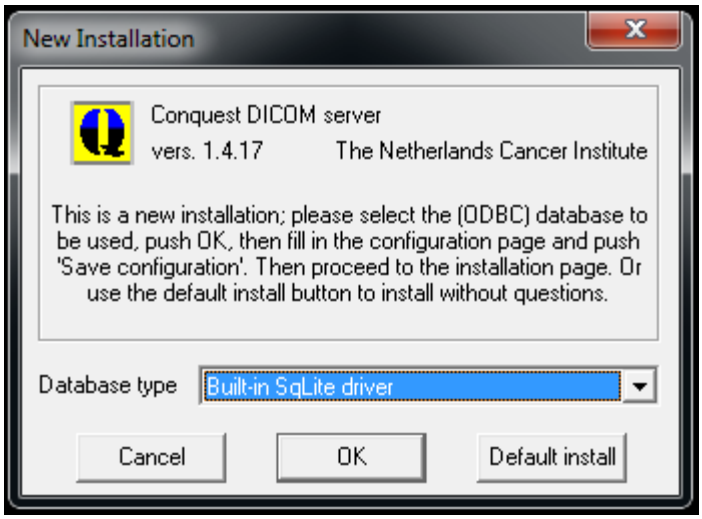


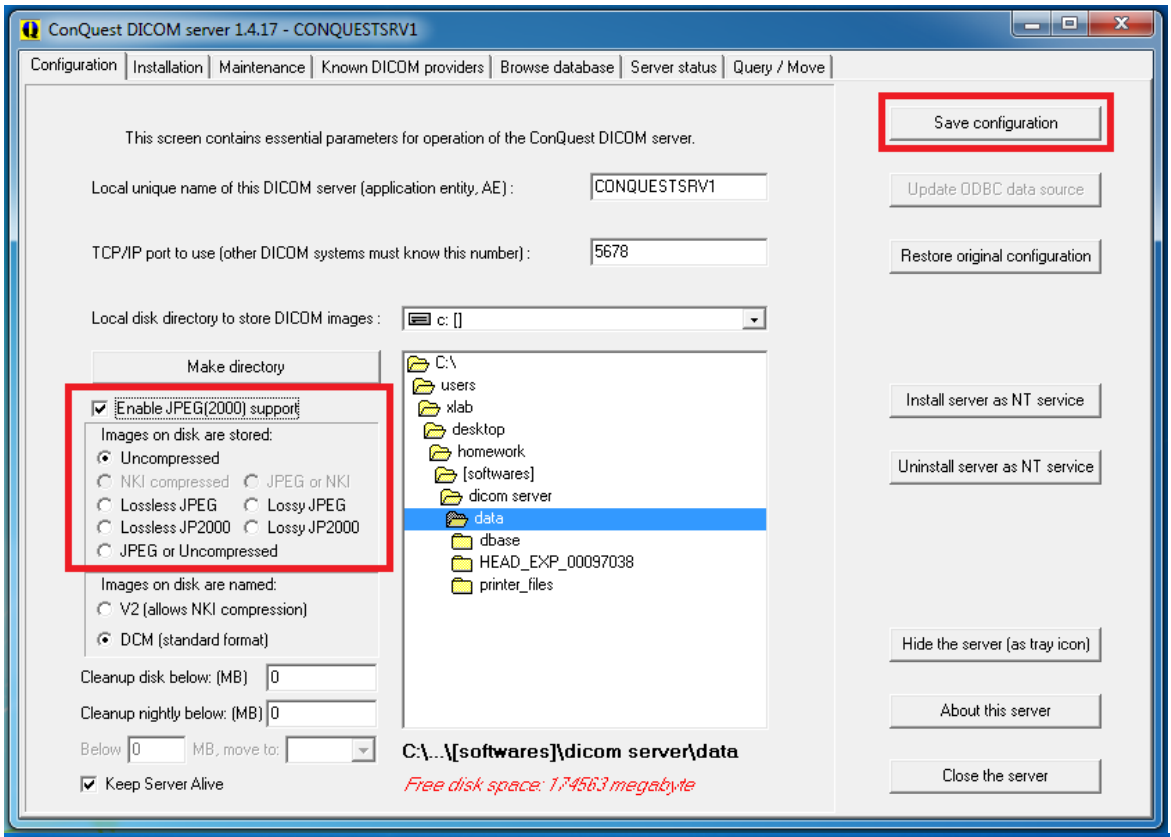
Figure 4-6 Selecting between different options of database driver.

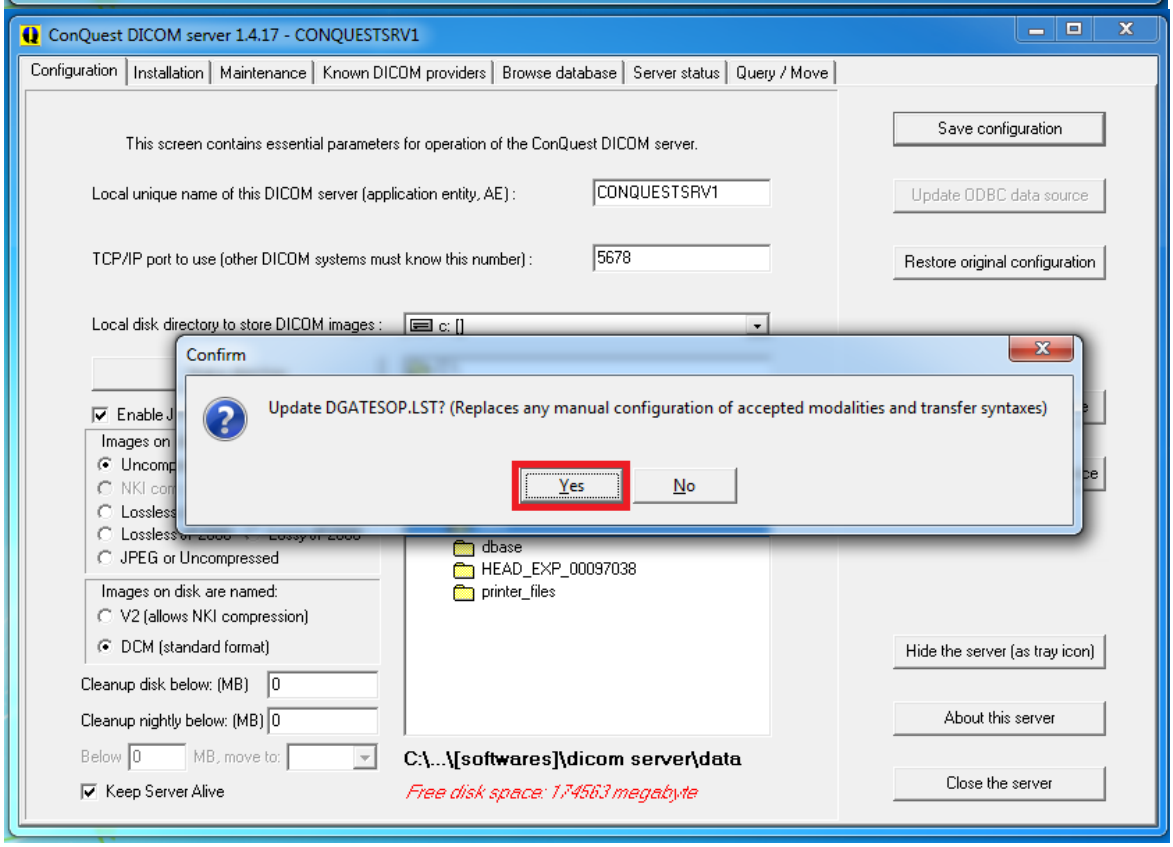
This window will appear for just first run

After conquest gets loaded, its GUI will appear (Fig. 4-7). Configuration tab is shown. On this tab, critical options of conquest are shown. AE is an arbitrary name, port number's default value is 5678. In windows 7 or vista this port may have already been taken by other programs. So, in the case of any problem in connection one can choose any other number in the range of 1000 to 65000. It is also possible to change the destination directory for saving images into[5].

On this tab we enable the "***Enable JPEG(2000) support***" check list , then select "***uncompressed***" and let the other section to be on their default values. After then "***Save configuration***" button must be pressed to make changes affect.

[5] We will back to this directory in the future sections.


ConQuest DICOM server 1.4.17 - CONQUESTSRV1
Configuration
Installation
Maintenance
Known DICOM providers
Browse database
Server status
Query / Move
This screen contains essential parameters for operation of the ConQuest DICOM server.
Local unique name of this DICOM server (application entity, AE) :
CONQUESTSRV1
TCP/IP port to use (other DICOM systems must know this number) :
5678
Local disk directory to store DICOM images :
c: []
Make directory
Enable JPEG(2000) support
Images on disk are stored:
Uncompressed
NKI compressed
JPEG or NKI
Lossless JPEG
Lossy JPEG
Lossless JP2000
Lossy JP2000
JPEG or Uncompressed
Images on disk are named:
V2 (allows NKI compression)
DCM (standard format)
Cleanup disk below: (MB)
0
Cleanup nightly below: (MB)
0
Below
0
MB, move to:
Keep Server Alive
C:\
users
xlab
desktop
homework
[softwares]
dicom server
data
dbase
HEAD_EXP_00097038
printer_files
C:\...\[softwares]\dicom server\data
Free disk space: 174563 megabyte
Save configuration
Update ODBC data source
Restore original configuration
Install server as NT service
Uninstall server as NT service
Hide the server (as tray icon)
About this server
Close the server


ConQuest DICOM server 1.4.17 - CONQUESTSRV1
Configuration
Installation
Maintenance
Known DICOM providers
Browse database
Server status
Query / Move
This screen contains essential parameters for operation of the ConQuest DICOM server.
Local unique name of this DICOM server (application entity, AE) :
CONQUESTSRV1
TCP/IP port to use (other DICOM systems must know this number) :
5678
Local disk directory to store DICOM images :
c: []
Confirm
Update DGATESOP.LST? (Replaces any manual configuration of accepted modalities and transfer syntaxes)
Yes
No
JPEG or Uncompressed
Images on disk are named:
V2 (allows NKI compression)
DCM (standard format)
Cleanup disk below: (MB)
0
Cleanup nightly below: (MB)
0
Below
0
MB, move to:
Keep Server Alive
dbase
HEAD_EXP_00097038
printer_files
C:\...\[softwares]\dicom server\data
Free disk space: 174563 megabyte
Save configuration
Update ODBC data source
Restore original configuration
Hide the server (as tray icon)
About this server
Close the server

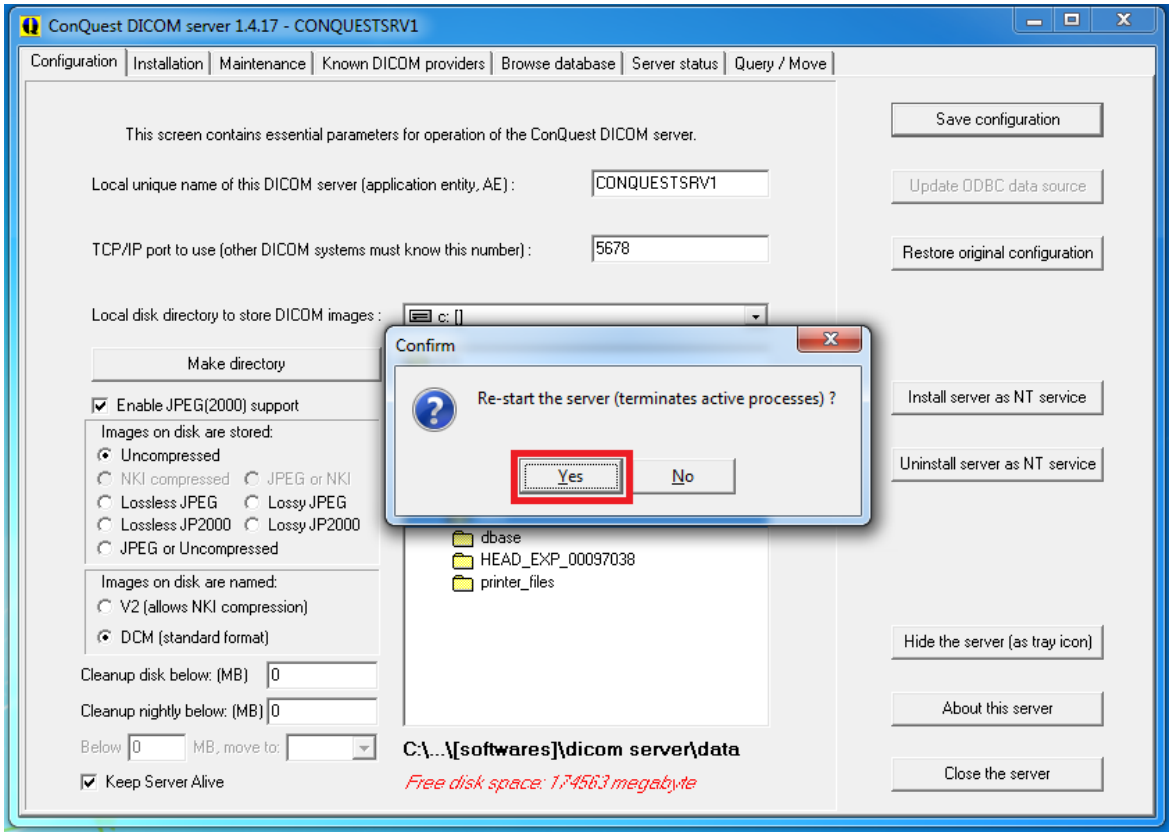


Figure 4-7 Configuring Conquest DICOM server

Now, let's keep moving on with installation tab. On this table one can verify conquest DICOM server connectivity. For this, the server starts to echo a long string into channel and in the case of normal situation it should hear its own voice! In other word, the long string that is sent by server, should be heard by itself and displayed on the screen.

In the case of successful test: "*Successful end of test*" is shown on the window and in the case of any failure "*can you read this?*" will appear. This later case means that the server cannot hear its own voice, so there should be problem with TCP/IP connection. Usually this test will be passed successfully, but if it did not happen to be the case then first try for a few more times than it is suggested to turn off firewalls and try it again (Fig. 4-8).

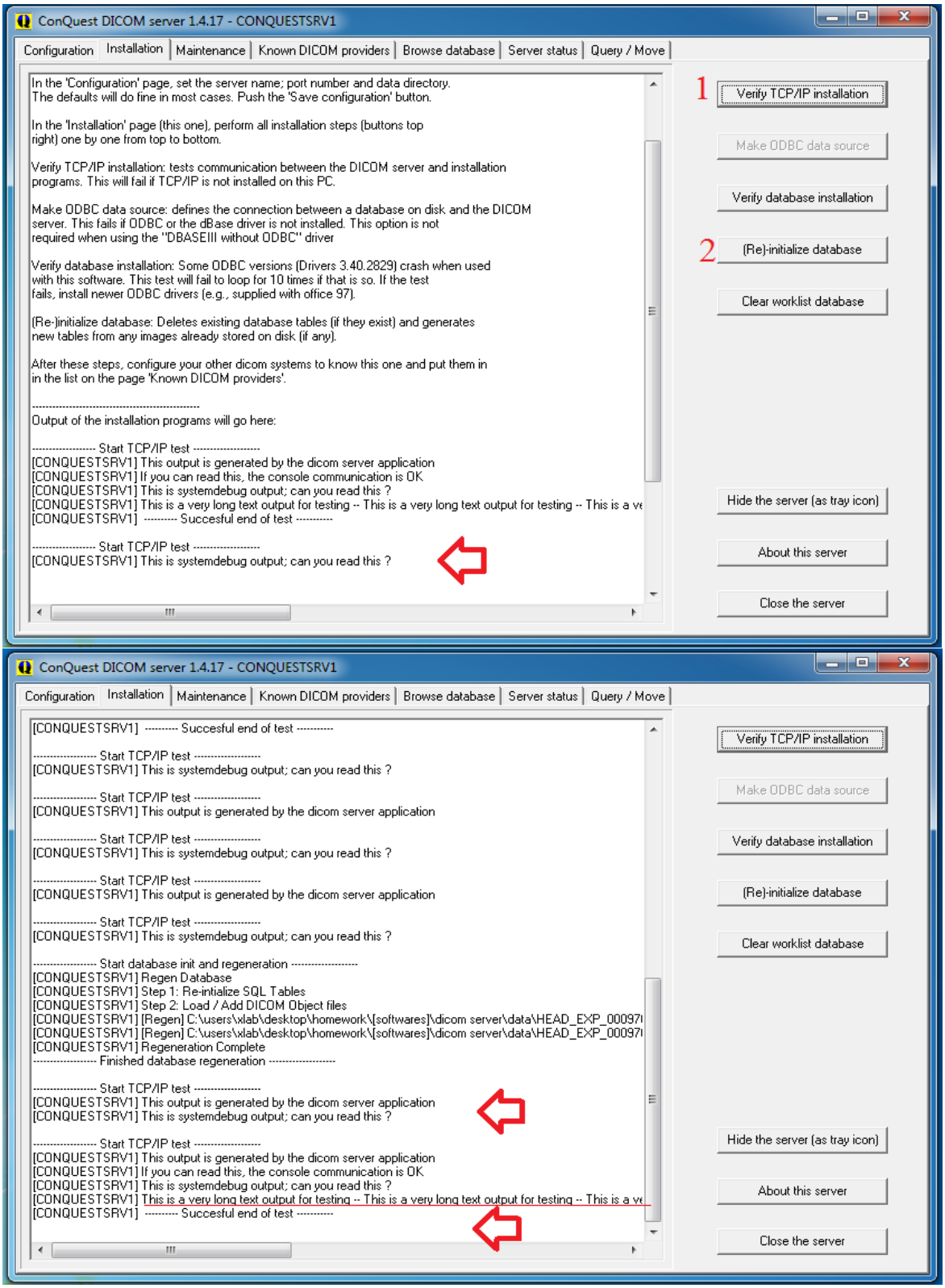


Figure 4-8 Verifying TCP/IP connectivity

In the case of collapse of data in the databases, it is possible to recover them from stored images. To do this one can use *(Re)-initialize database*. This option is a little bit advanced for beginners. Those how want to use conquest in conjunction with SQL server might check it out. But for now one can ignore that. By pressing "*Verify database installation*" button, verify database.

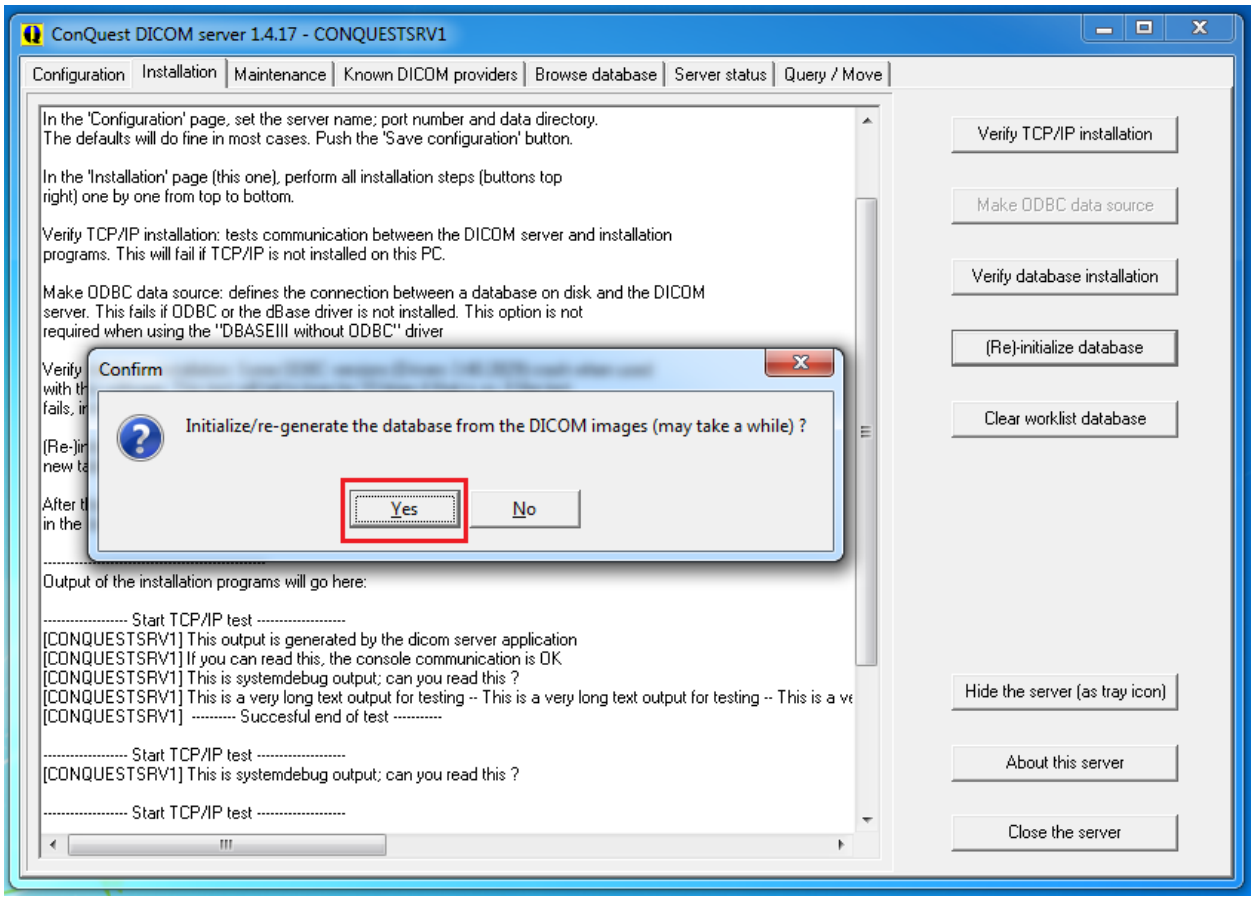
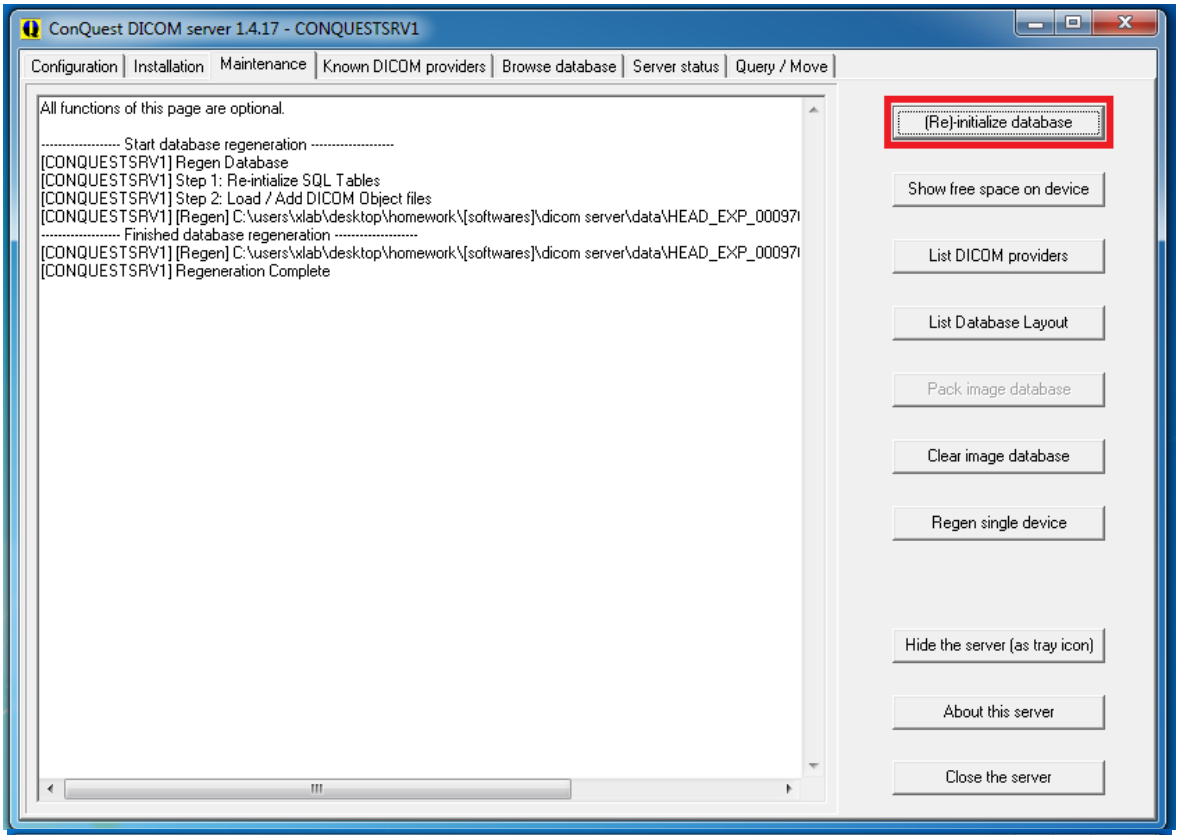
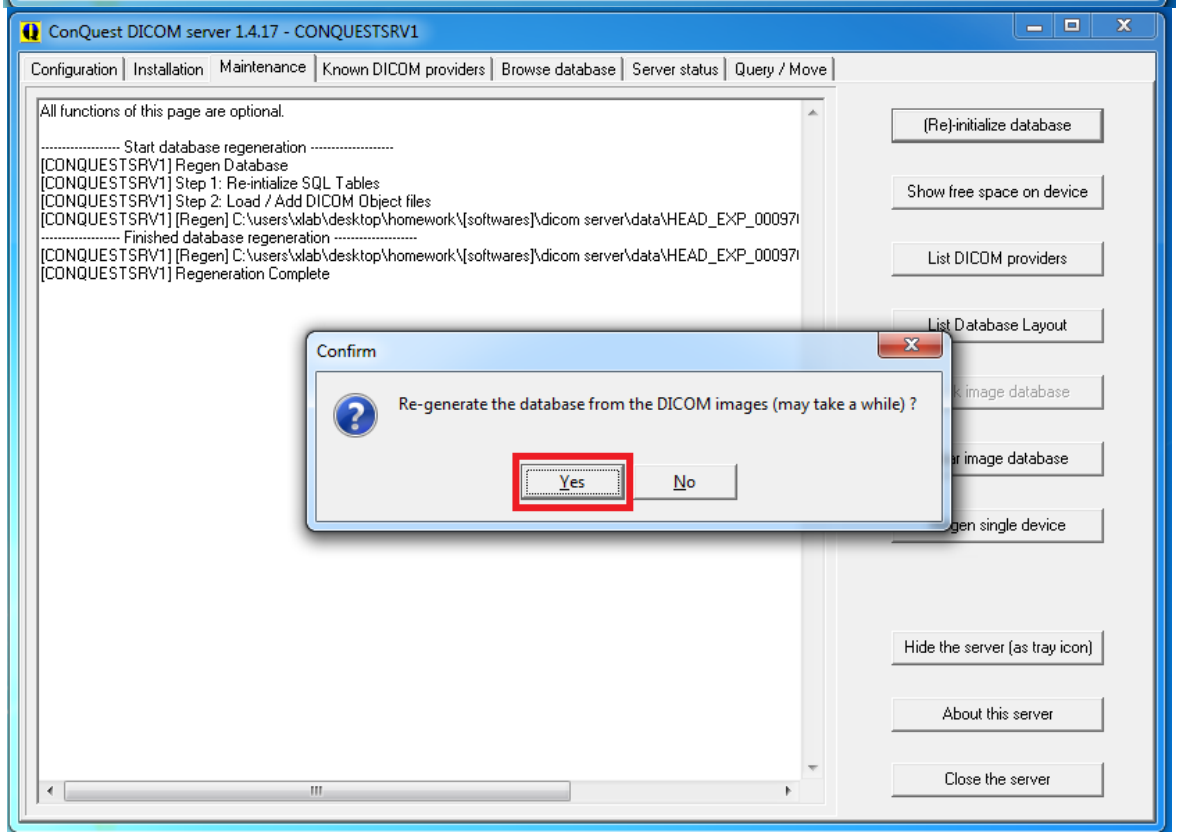


Figure 4-9 Initialize databases

On the maintenance tab there is also (Re)-initialize button. The functionality of this button is similar to the one within the installation tab. For now, we recommend the reader to press it down to see what happen but in the future he should be a conservative on this option. The remaining buttons return back a report on databases, so it would be a good practice to check all of them. Fig. 4-10


ConQuest DICOM server 1.4.17 - CONQUESTSRV1
Configuration
Installation
Maintenance
Known DICOM providers
Browse database
Server status
Query / Move
All functions of this page are optional.
---------- Start database regeneration ----------
[CONQUESTSRV1] Regen Database
[CONQUESTSRV1] Step 1: Re-initialize SQL Tables
[CONQUESTSRV1] Step 2: Load / Add DICOM Object files
[CONQUESTSRV1] [Regen] C:\users\xlab\desktop\homework\[softwares]\dicom server\data\HEAD_EXP_00097
---------- Finished database regeneration ----------
[CONQUESTSRV1] [Regen] C:\users\xlab\desktop\homework\[softwares]\dicom server\data\HEAD_EXP_00097
[CONQUESTSRV1] Regeneration Complete
(Re)-initialize database
Show free space on device
List DICOM providers
List Database Layout
Pack image database
Clear image database
Regen single device
Hide the server (as tray icon)
About this server
Close the server


ConQuest DICOM server 1.4.17 - CONQUESTSRV1
Configuration
Installation
Maintenance
Known DICOM providers
Browse database
Server status
Query / Move
All functions of this page are optional.
---------- Start database regeneration ----------
[CONQUESTSRV1] Regen Database
[CONQUESTSRV1] Step 1: Re-initialize SQL Tables
[CONQUESTSRV1] Step 2: Load / Add DICOM Object files
[CONQUESTSRV1] [Regen] C:\users\xlab\desktop\homework\[softwares]\dicom server\data\HEAD_EXP_00097
---------- Finished database regeneration ----------
[CONQUESTSRV1] [Regen] C:\users\xlab\desktop\homework\[softwares]\dicom server\data\HEAD_EXP_00097
[CONQUESTSRV1] Regeneration Complete
Confirm
Re-generate the database from the DICOM images (may take a while) ?
Yes
No
(Re)-initialize database
Show free space on device
List DICOM providers
List Database Layout
Hide the server (as tray icon)
About this server
Close the server

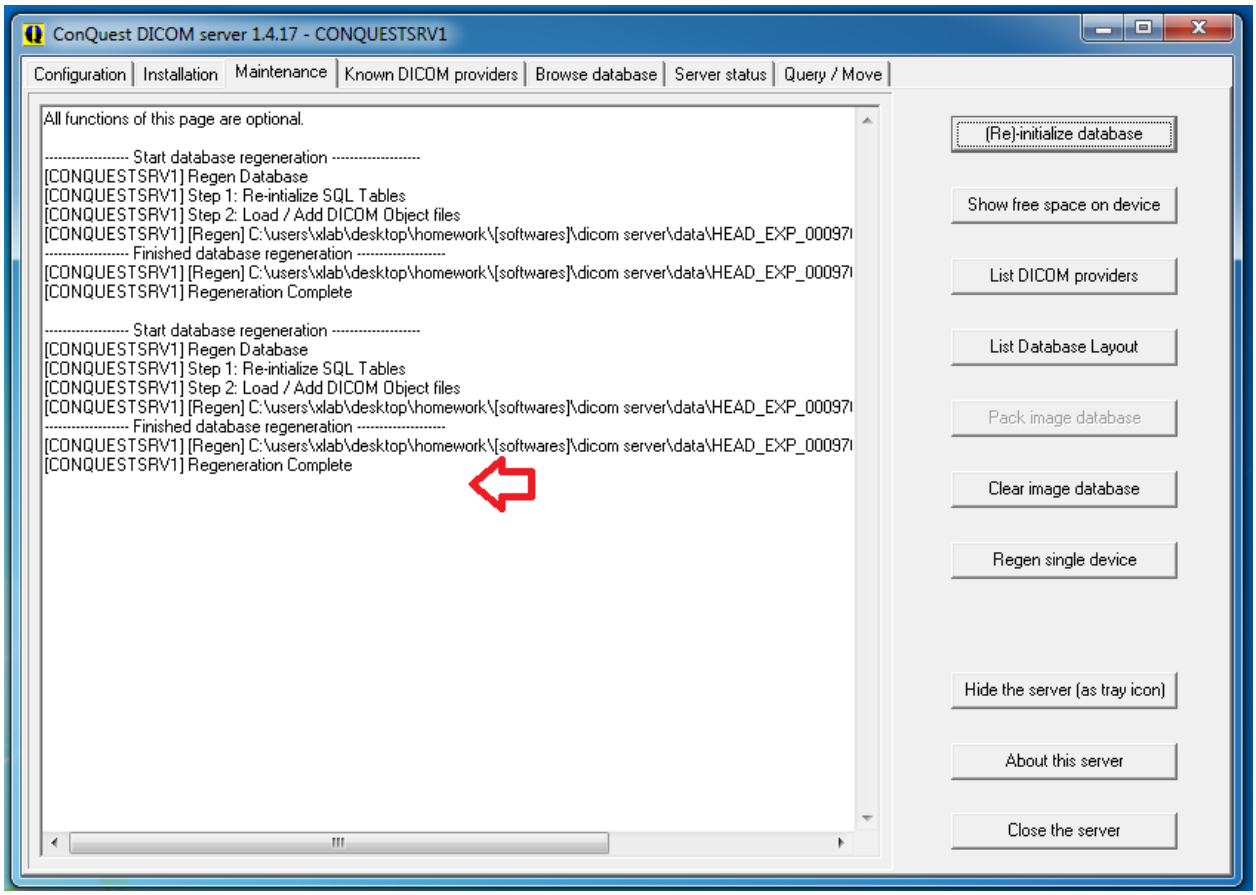
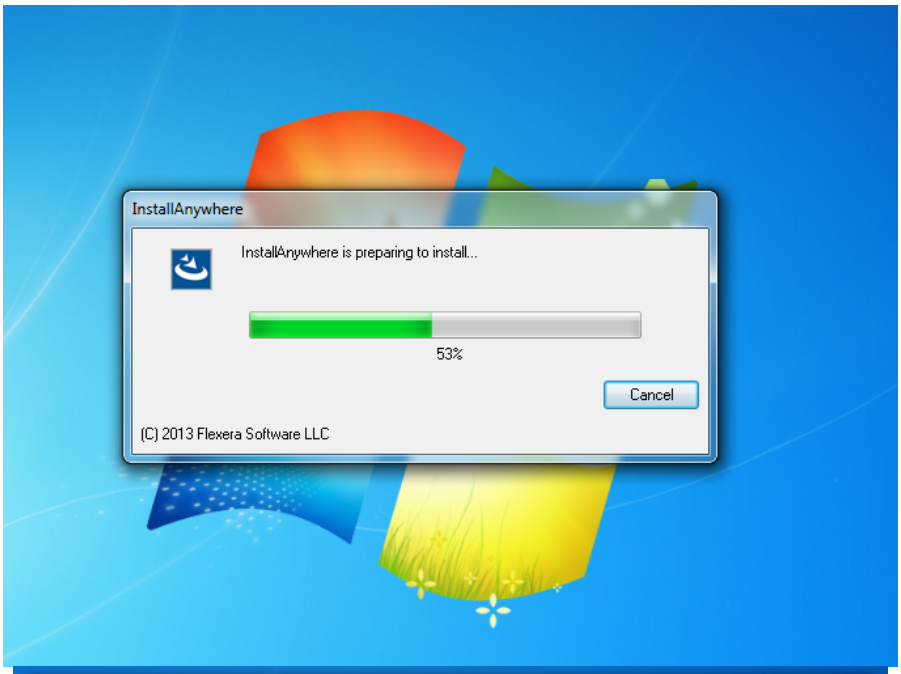
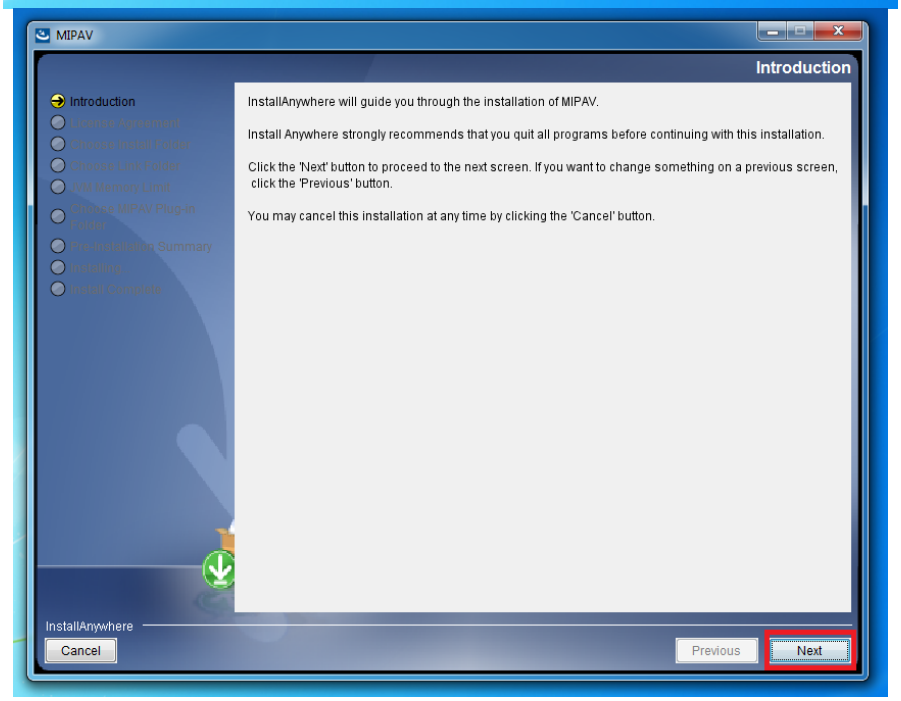


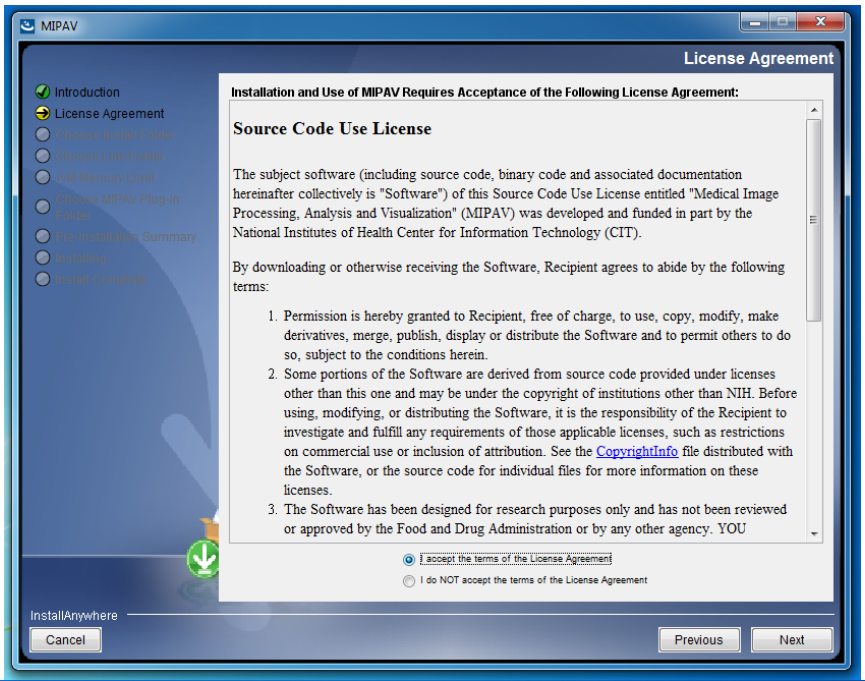
Figure 4-10 maintenance tab and re-initialization

Setting up MIPAV

Setting up MIPAV is straight forward. Figure 4-11 shows the steps. Figure 4-12 pictures main window of MIPAV.


InstallAnywhere
InstallAnywhere is preparing to install...
53%
Cancel
(C) 2013 Flexera Software LLC


MIPAV
Introduction
Introduction
License Agreement
Choose Install Folder
Choose Link Folder
JVM Memory Limit
Choose MIPAV Plug-in Folder
Pre-Installation Summary
Installing
Install Complete
InstallAnywhere will guide you through the installation of MIPAV.
Install Anywhere strongly recommends that you quit all programs before continuing with this installation.
Click the 'Next' button to proceed to the next screen. If you want to change something on a previous screen, click the 'Previous' button.
You may cancel this installation at any time by clicking the 'Cancel' button.
InstallAnywhere
Cancel
Previous
Next


MIPAV
License Agreement
Introduction
License Agreement
Choose Install Folder
Choose Link Folder
JVM Memory Limit
Choose MIPAV Plug-in Folder
Pre-Installation Summary
Installing
Install Complete
Installation and Use of MIPAV Requires Acceptance of the Following License Agreement:
Source Code Use License
The subject software (including source code, binary code and associated documentation hereinafter collectively is "Software") of this Source Code Use License entitled "Medical Image Processing, Analysis and Visualization" (MIPAV) was developed and funded in part by the National Institutes of Health Center for Information Technology (CIT).
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1. Permission is hereby granted to Recipient, free of charge, to use, copy, modify, make derivatives, merge, publish, display or distribute the Software and to permit others to do so, subject to the conditions herein.
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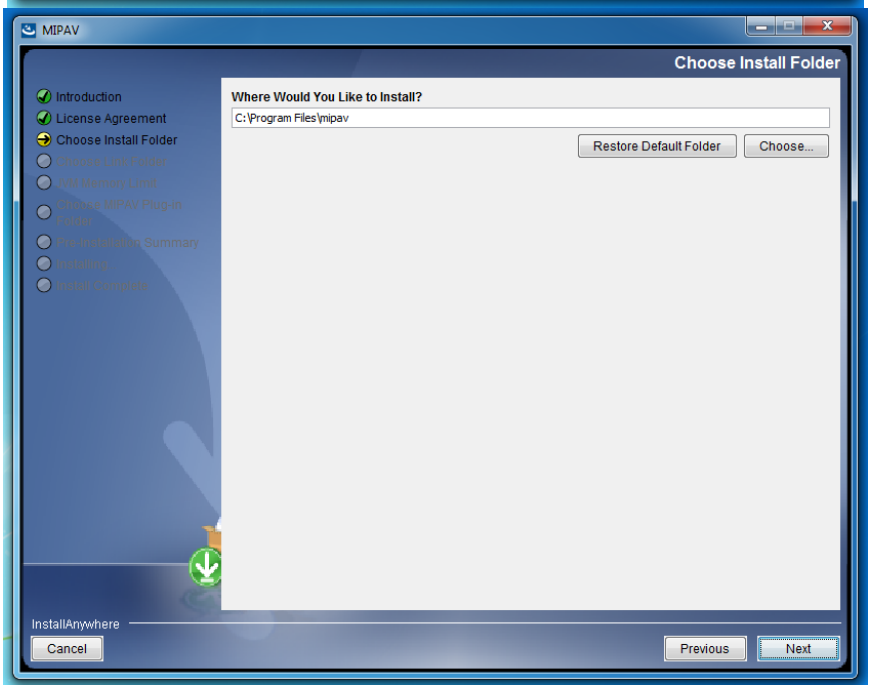
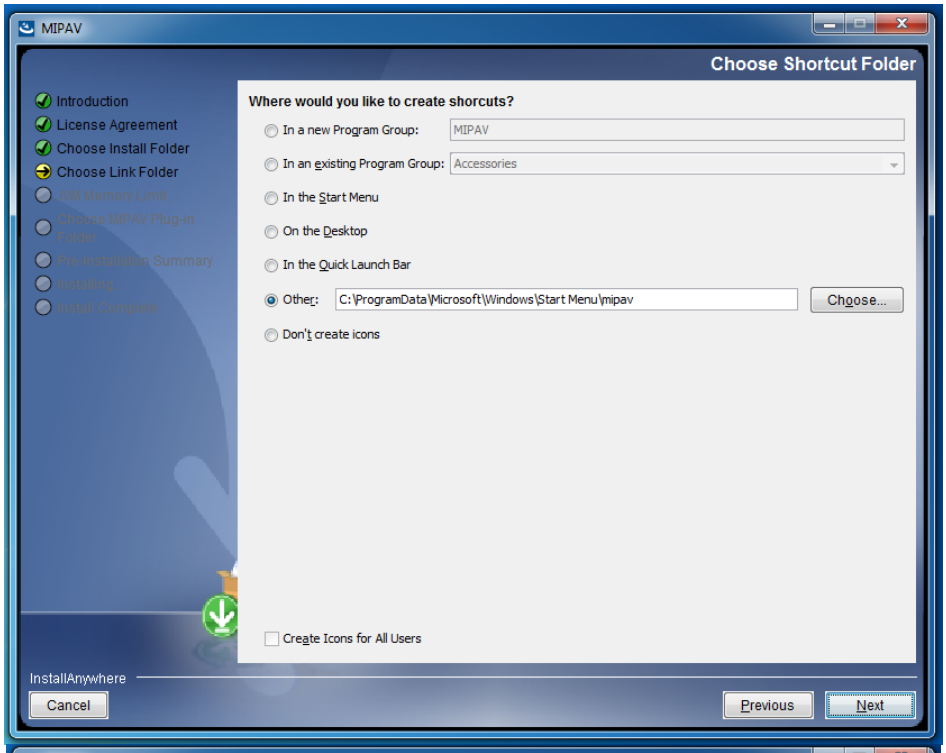
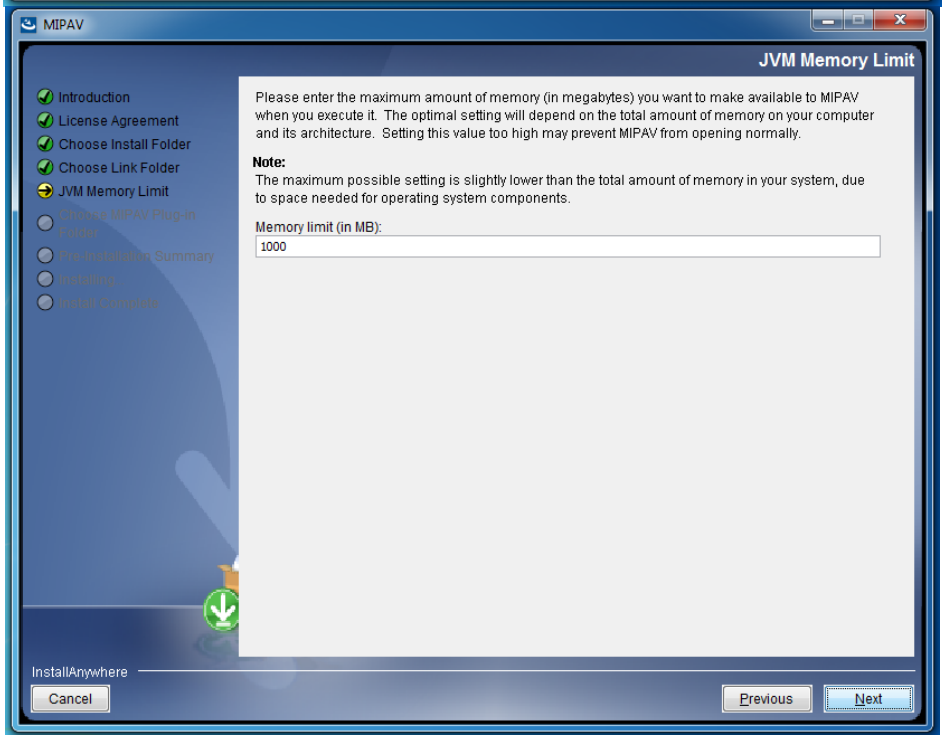
3. The Software has been designed for research purposes only and has not been reviewed or approved by the Food and Drug Administration or by any other agency. YOU
I accept the terms of the License Agreement
I do NOT accept the terms of the License Agreement
InstallAnywhere
Cancel
Previous
Next


MIPAV
Choose Install Folder
Introduction
License Agreement
Choose Install Folder
Choose Link Folder
JVM Memory Limit
Choose MIPAV Plug-in Folder
Pre-Installation Summary
Installing
Install Complete
Where Would You Like to Install?
C:\Program Files\mipav
Restore Default Folder
Choose...
InstallAnywhere
Cancel
Previous
Next


MIPAV
Choose Shortcut Folder
Introduction
License Agreement
Choose Install Folder
Choose Link Folder
JVM Memory Limit
Choose MIPAV Plug-in Folder
Pre-Installation Summary
Installing...
Install Complete
Where would you like to create shorcuts?
In a new Program Group: MIPAV
In an existing Program Group: Accessories
In the Start Menu
On the Desktop
In the Quick Launch Bar
Other: C:\ProgramData\Microsoft\Windows\Start Menu\mipav
Choose...
Don't create icons
Create Icons for All Users
InstallAnywhere
Cancel
Previous
Next


MIPAV
JVM Memory Limit
Introduction
License Agreement
Choose Install Folder
Choose Link Folder
JVM Memory Limit
Choose MIPAV Plug-in Folder
Pre-Installation Summary
Installing...
Install Complete
Please enter the maximum amount of memory (in megabytes) you want to make available to MIPAV when you execute it. The optimal setting will depend on the total amount of memory on your computer and its architecture. Setting this value too high may prevent MIPAV from opening normally.
Note:
The maximum possible setting is slightly lower than the total amount of memory in your system, due to space needed for operating system components.
Memory limit (in MB):
1000
InstallAnywhere
Cancel
Previous
Next

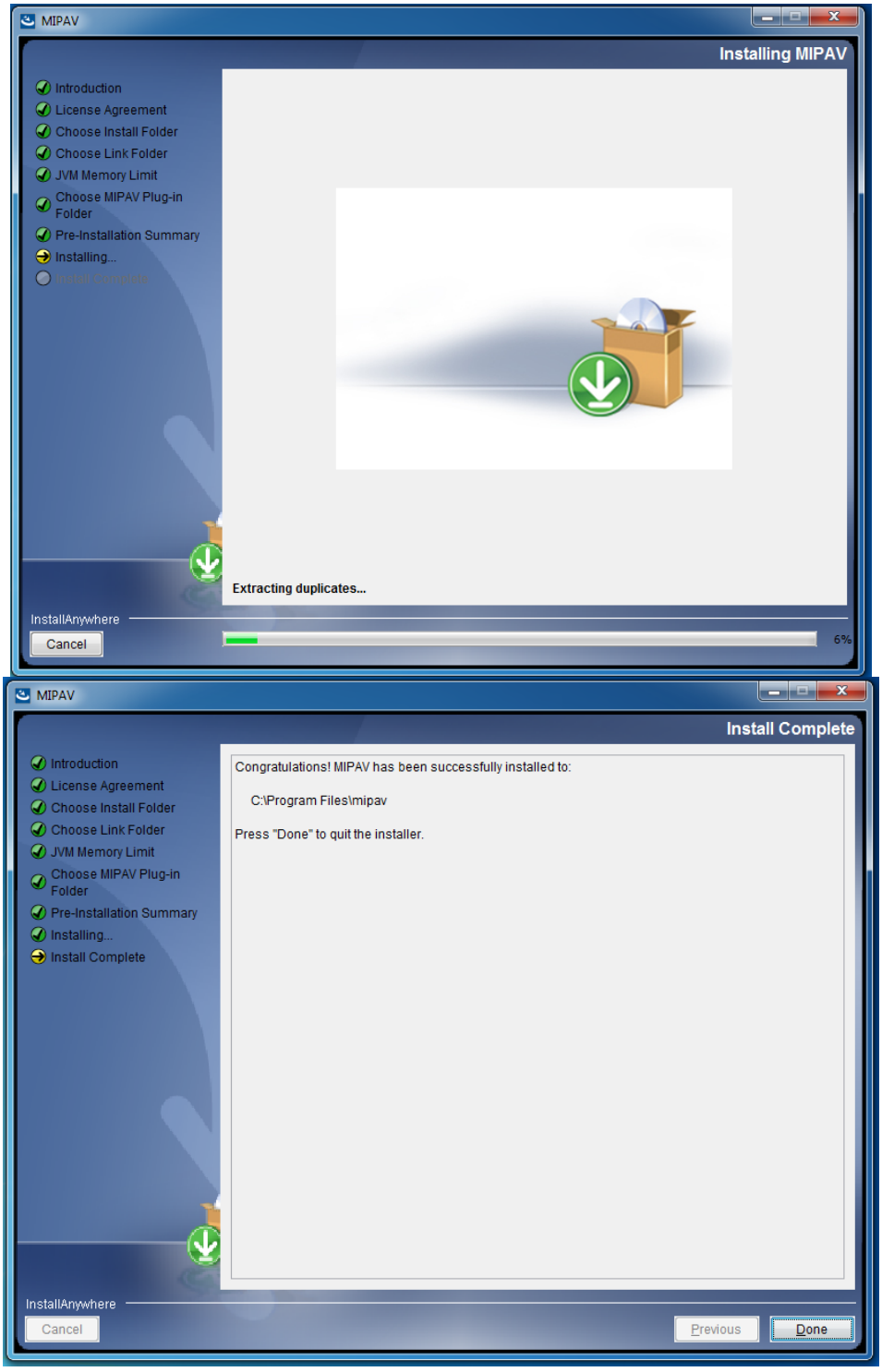


Figure 4-11 installation process

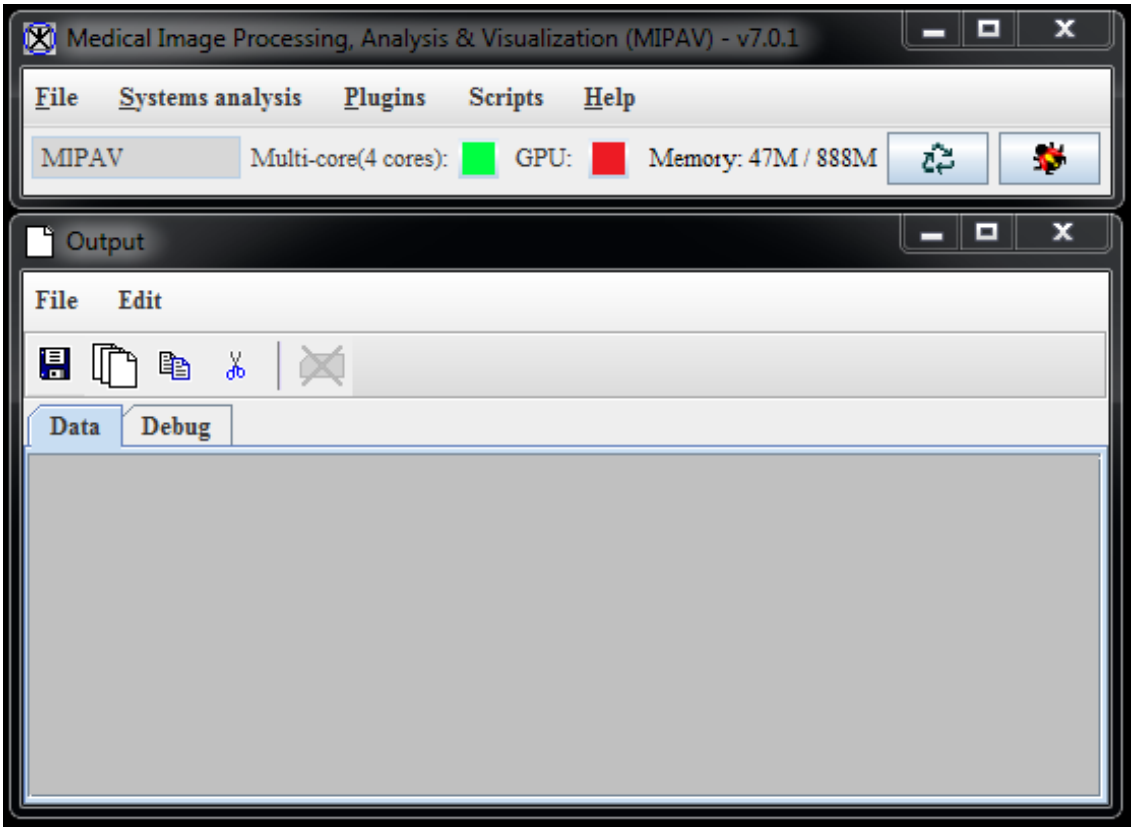
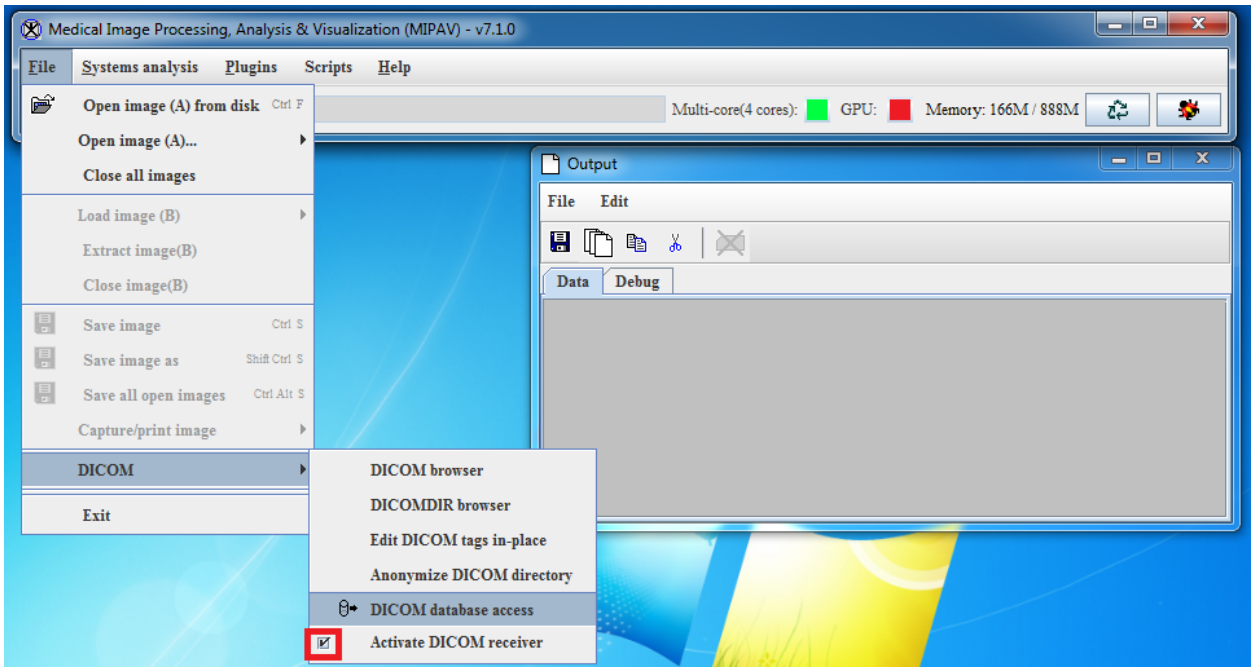


Figure 4-12 MIPAV main window

Connecting MIPAV to Conquest

It is time for major step which is connecting MIPAV to Conquest. First, check the ***Active DICOM receiver*** (Fig. 14.13). This option allows the MIPAV to receive data from server. Then, select ***DICOM database access***. On the opened window, go to ***Hosts*** tab. There are two panels within, one for *servers* and the other is for *storage*. Server panel list all servers which are introduced to MIPAV and Storage Destination lists all local storage which are used by MIPAV during image transfer (Fig. 14.13) As far as this is the first time the MIPAV is going to be used, these lists are empty on Fig. 14.13. Next, let's start with creating new server.



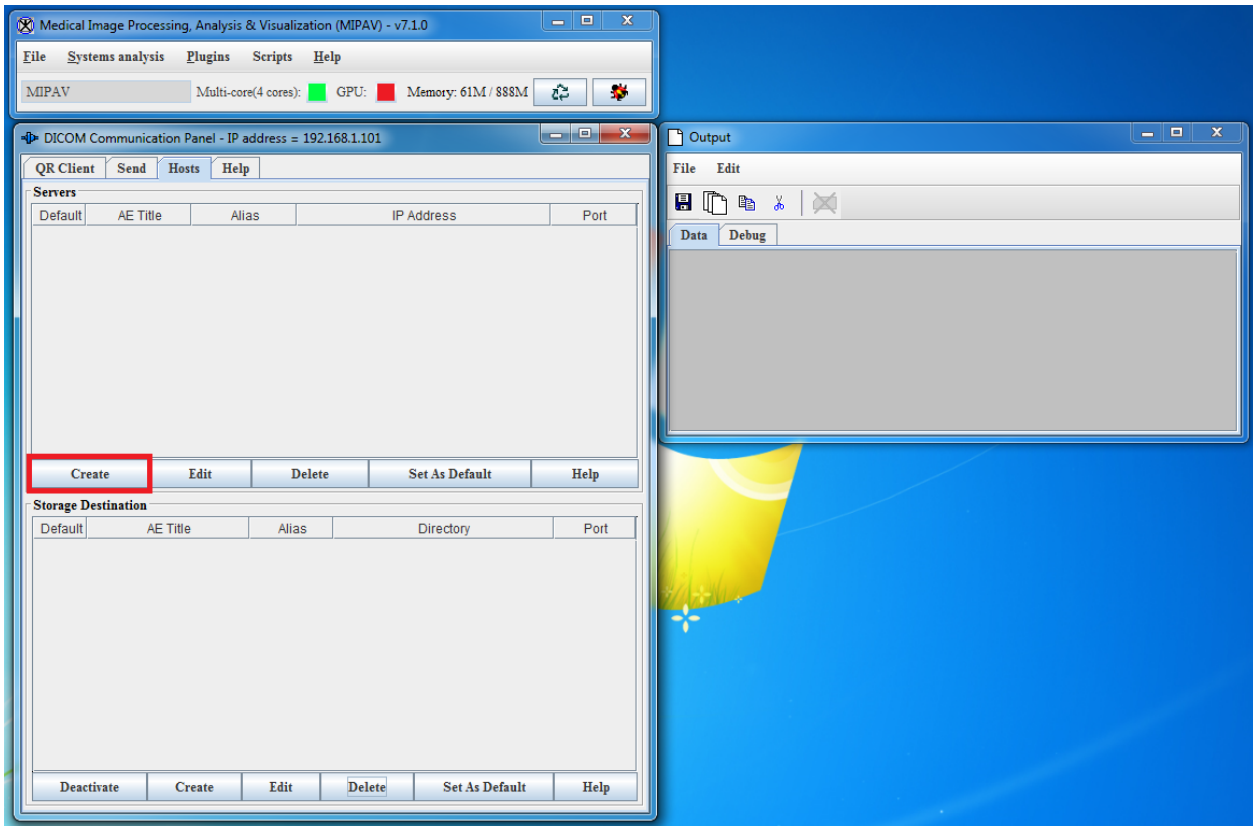


Figure 4-13 introducing conquest to MIPAV

MIPAV needs IP, AE and port number of the conquest server. This information can be extracted from "***Known DICOM providers***" tab in conquest. Beside these, an extra *arbitrary* name[6] ***Alias*** is also needed.

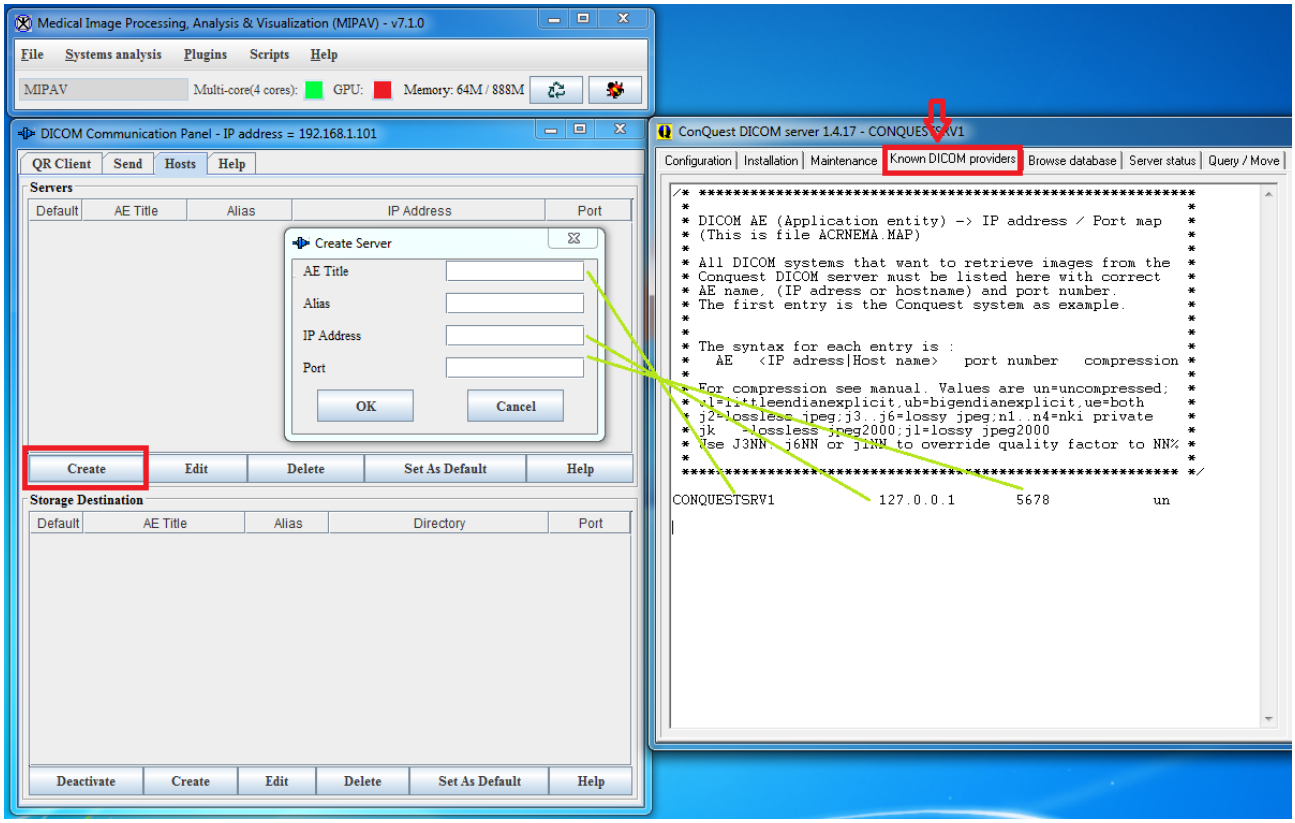


Figure 4-14 Passing conquest parameters to MIPAV

Fig. 4-14 shows an example. After introducing the server(s), we have to select one default server. So, after making new server, select it from the list and press ***Set As Default.*** Make sure the tike mark appears beside the server name.

[6] which is used if the server name confliction happens

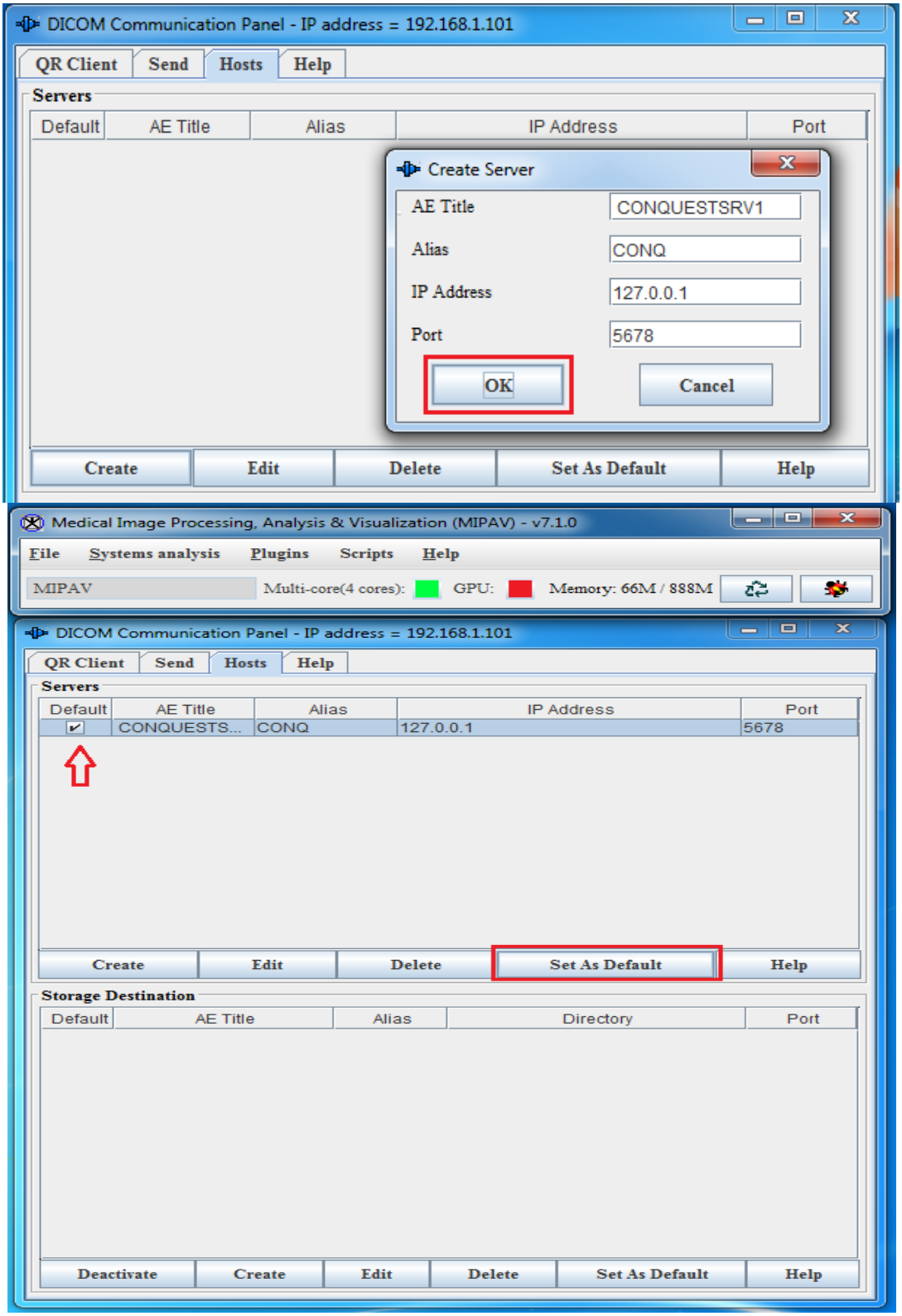
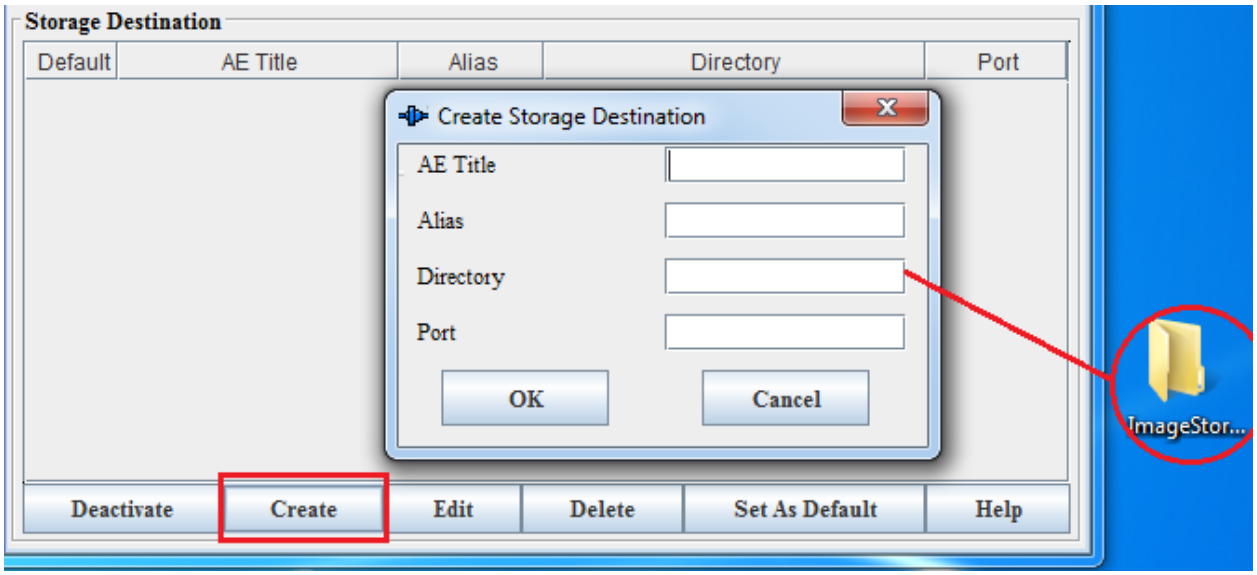
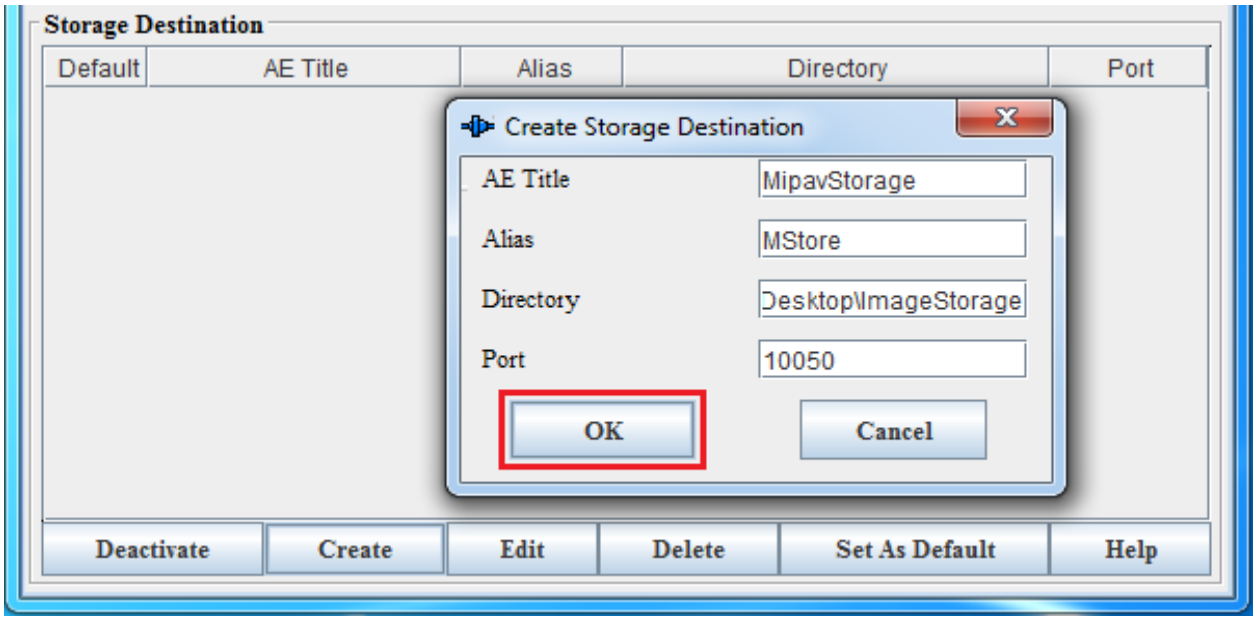


Figure 4-15 Example on how to introduce a server to MIPAV

MIPAV needs a cache as a temporary space to keep incoming images from server in. So, make a folder on an appropriate location. Its address accompanied with ***arbitrary*** AE name, ***arbitrary*** alias AE name and an ***arbitrary*** port number[7] is passed to MIPAV and it made as a default storage. These steps are shown in Fig. 4-16





[7] In the range of 1000 to 65000

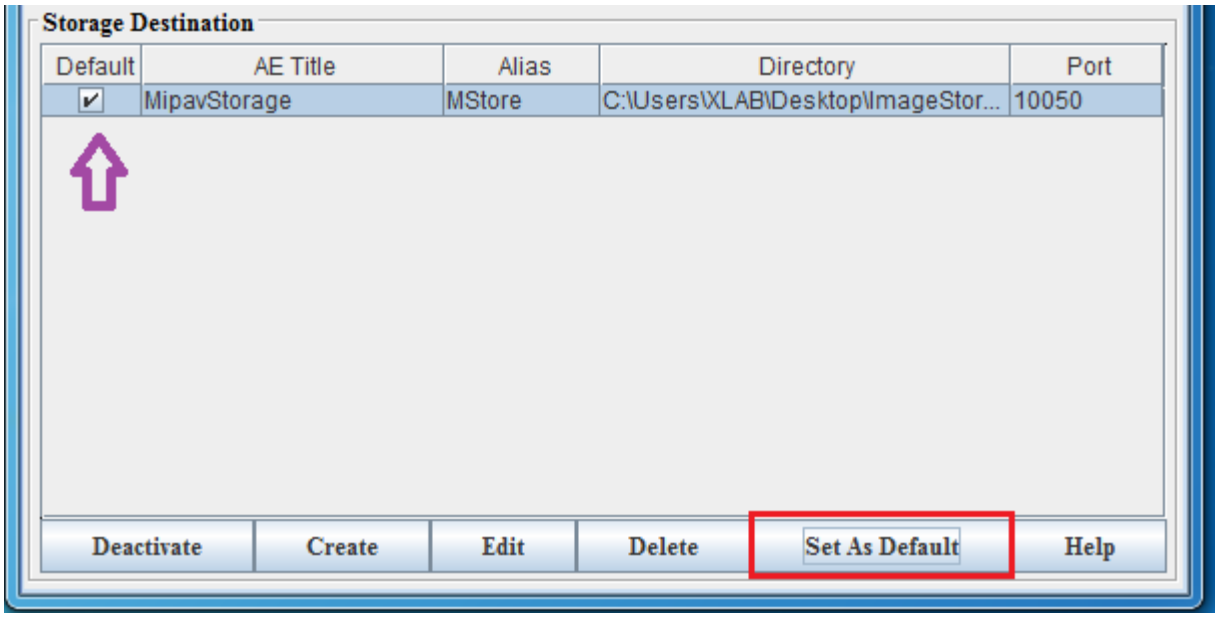


Figure 4-16 making an storage destination

Action Time

After configuring hosts, let's test if everything goes ok or not. Go to ***Send*** Tab press the ***Brows*** button and steer the folder in which sample DICOM images are located in (Fig. 4-17). In this example we have three images in our sample-DICOM-images folder, which are *chest*, *knee3* and *pelvis* (Fig. 4-18).

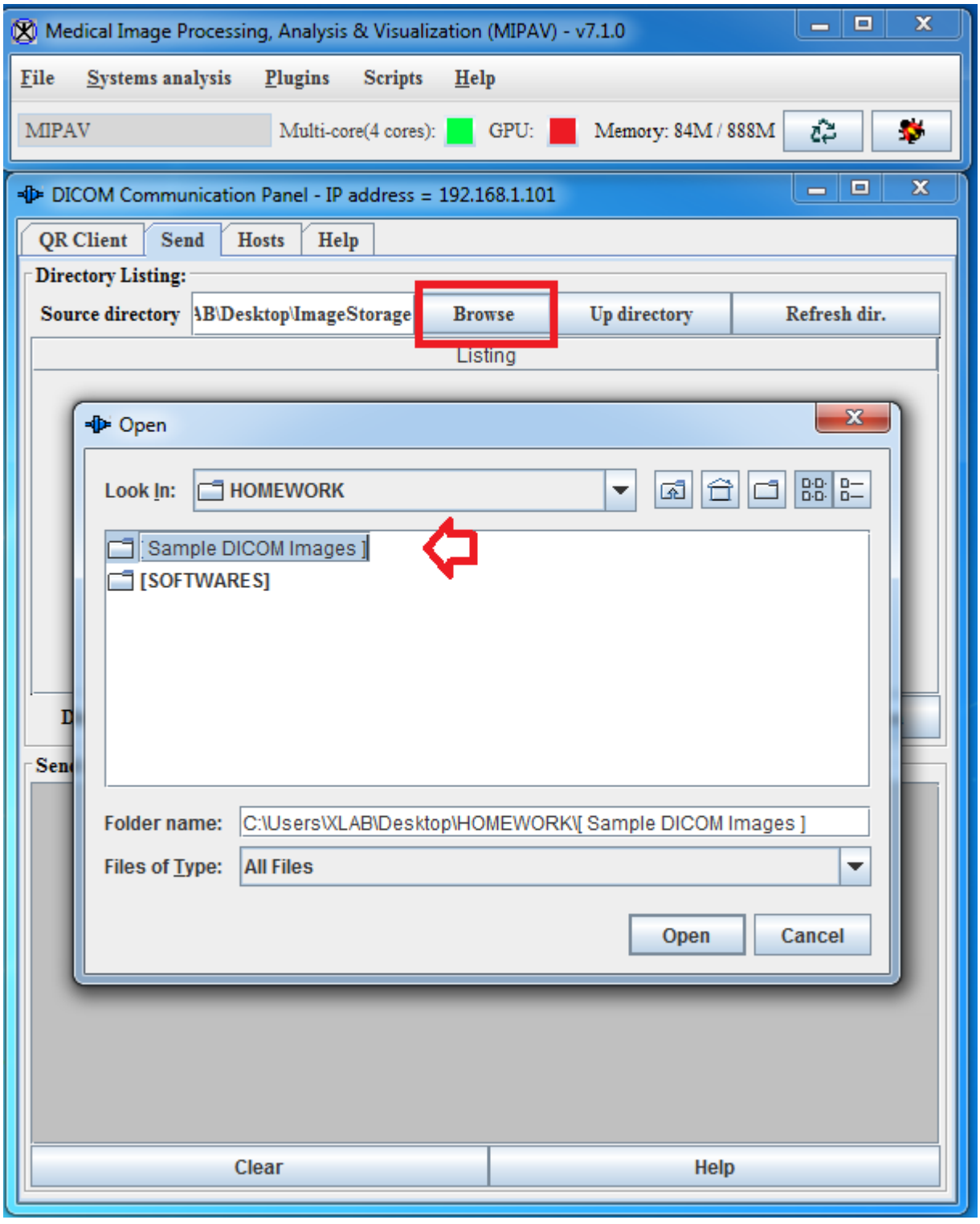


Figure 4-17 Locate sample image files

Now it is the moment of the truth! First lets test if is there any problem in communication line or not. So press, ***Test Connection***. (Fig. 4-18) If everything goes well a success message will appear, otherwise, there is a problem with server definition or conquest is not working properly.

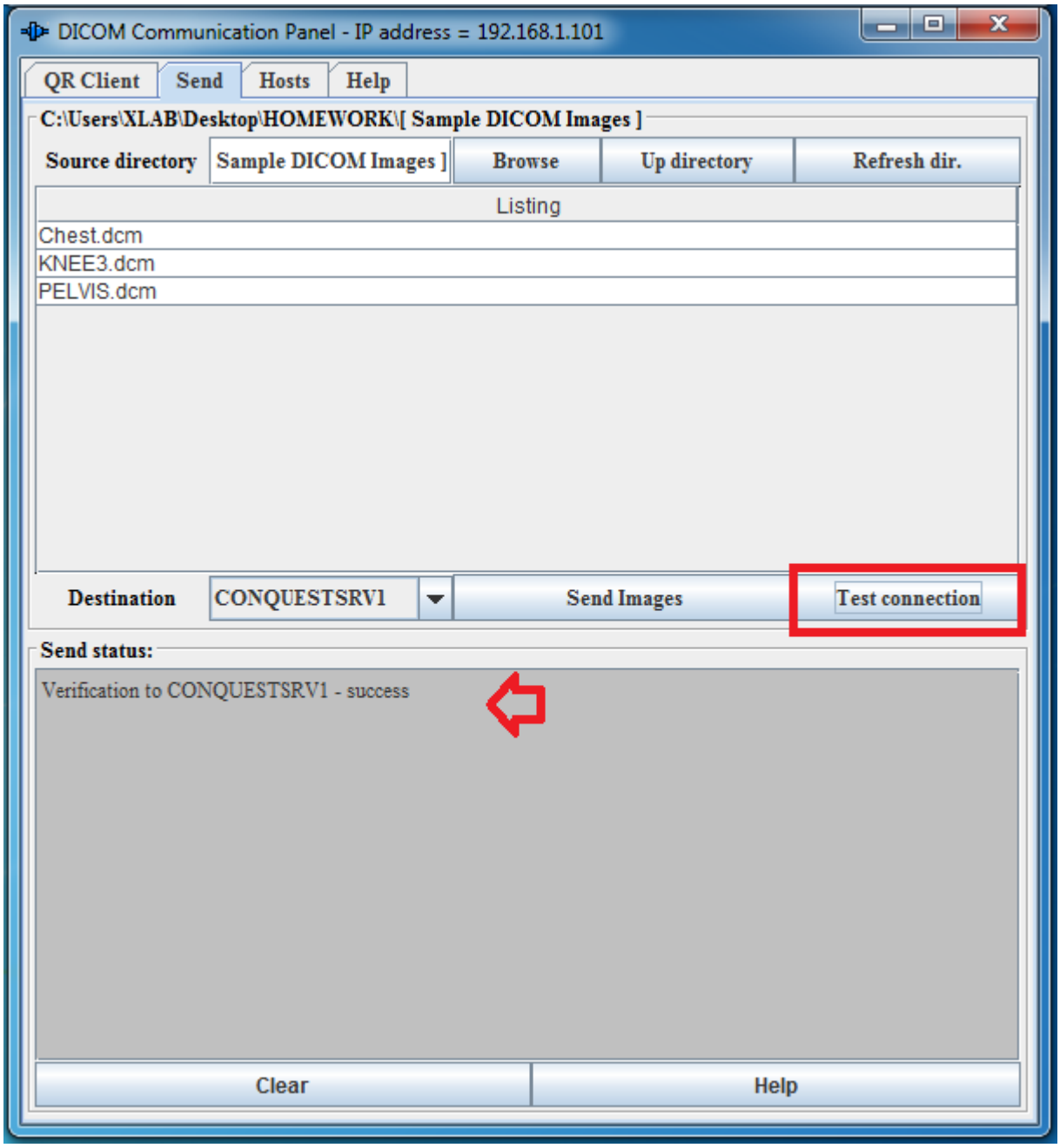


Figure 4-18 checking for connection

Now, let's try sending image. Select one of the images from the list and then press ***Send Images*** button. Bring into mind, images are bulky creatures so it may take a little while to complete the operation.

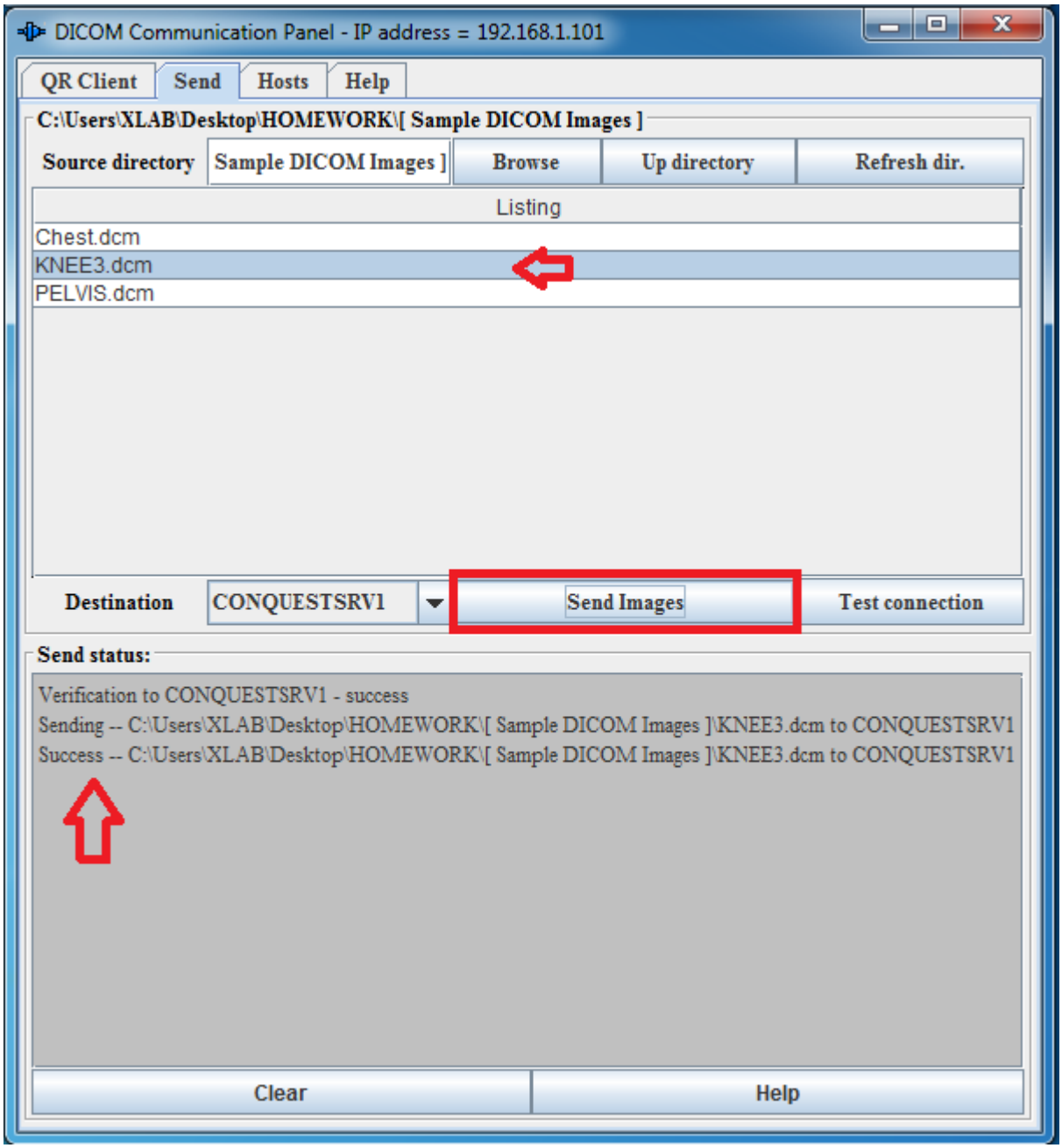


Figure 4-19 checking for image transfer

At this point if everything goes well, then congratulations!!! You just implemented a DICOM server which costs so much just a few years ago!!!

After a successful connection and image transfer, now let's see what happens on the server side. Usually servers keep a log from their activities, same goes for conquest. Under Server status one can see what happened just after we have tested connection and sending images.

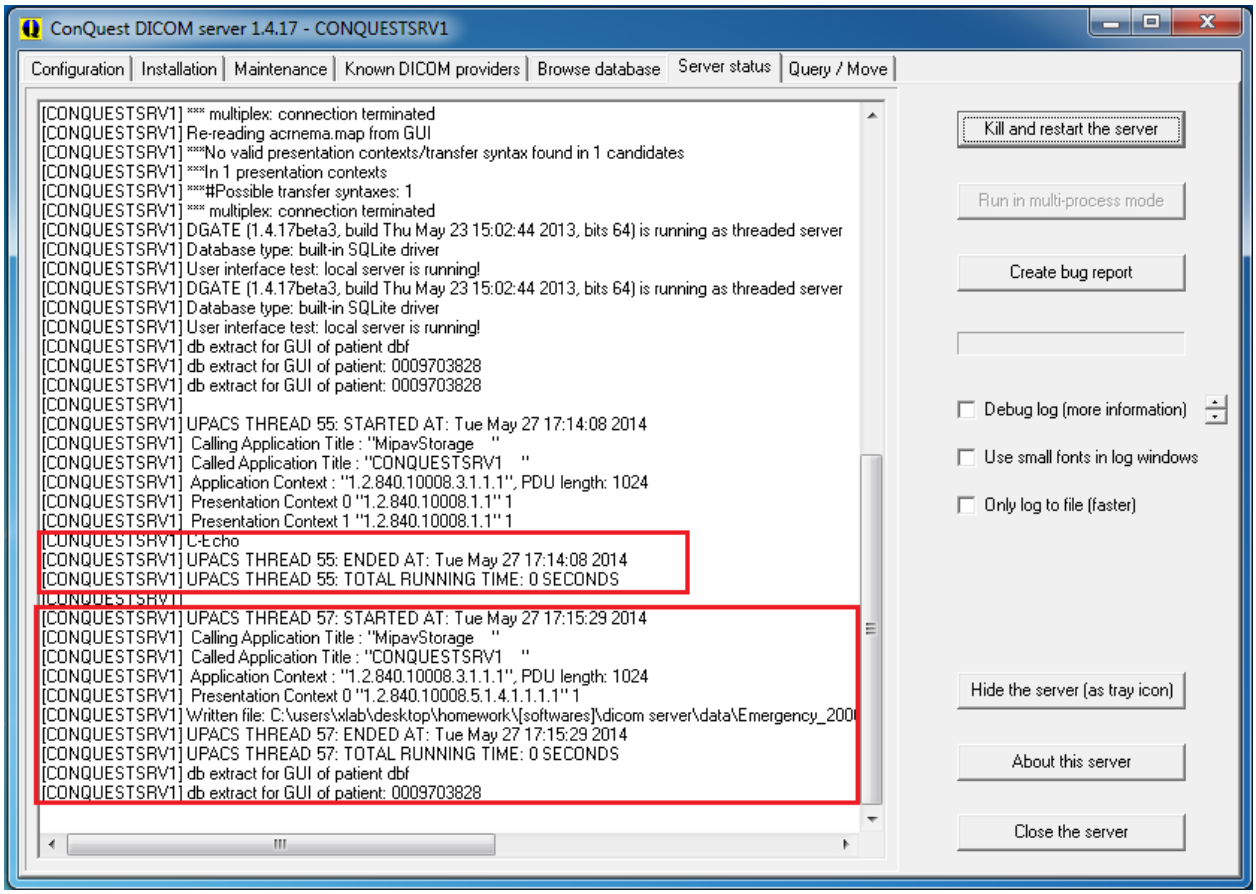


Figure 4-20 Conquest status connected to MIPAV. The first section is report of connection test and the second section is of image transfer

Curiosity

After successful connection, let's peep over some aspects of conquest. First, let's make sure the image is received by conquest and then check where it is saved. Open the conquest DICOM server and go to ***browse database*** tab. On the top left corner one can see the image is really received! (Fig. 4-21)

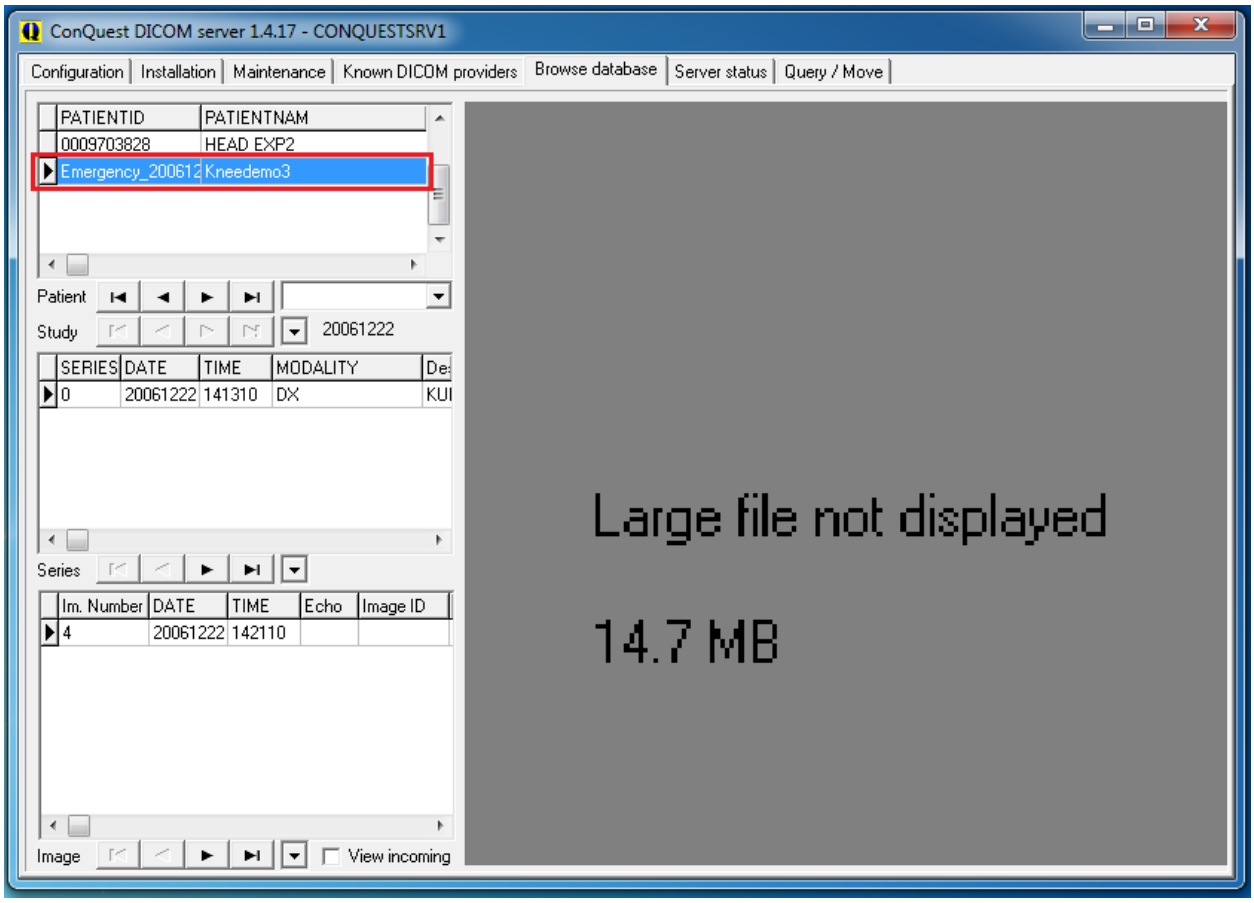


Figure 4-21 Received image is in Conquest database

On this figure a message is interesting, "*Large file not displayed*". Conquest DICOM server comes with a built in primitive DICOM viewer. This viewer cannot able to show large images (like the one we have here, which is almost 16 MB) To solve this problem conquest is also augmented with a third-party viewer *k-Pacs*. To see the image, right click on the message and select Run K-Packs viewer (Fig. 4-22)

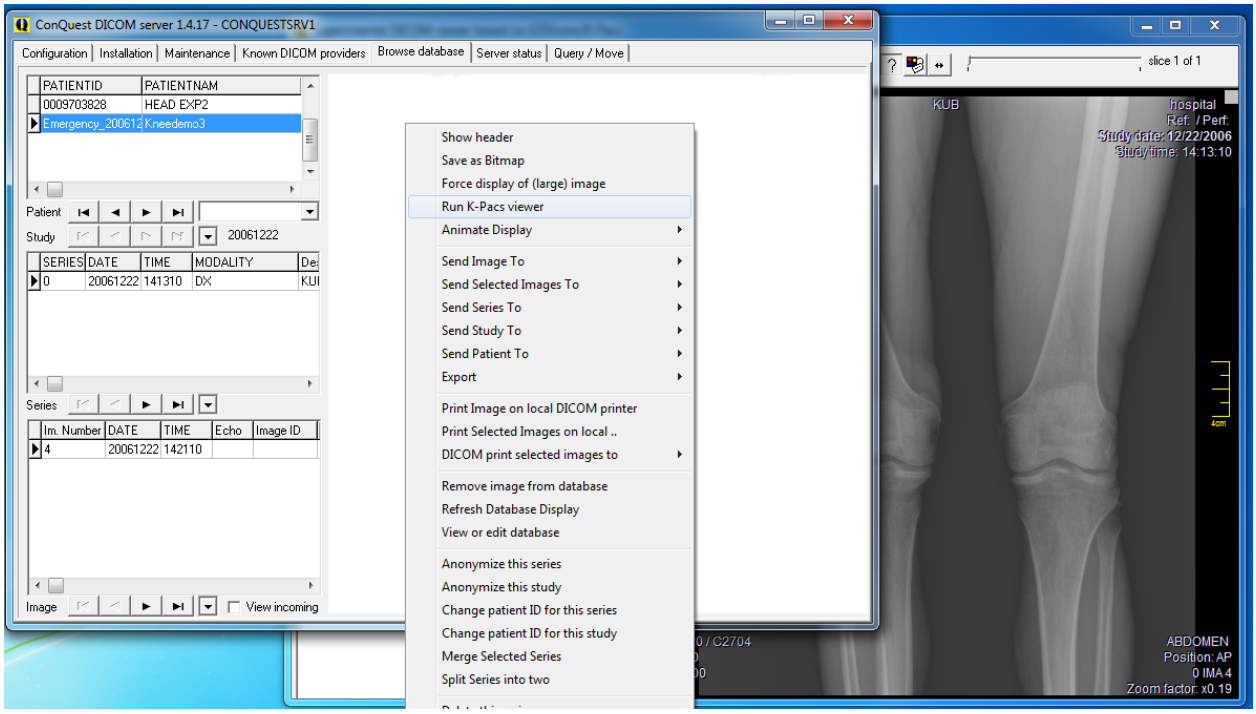


Figure 4-22 K-Pacs viewer

One might also ask where did HEAD XP2 come from? It is a built in sample which come with conquest.

That was the image, so where is the meta-data? Where are they? A closer look at the Fig 4-21 shows that there are three tables beside the image. Each table shows some section of meta-data (Fig. 4-23).

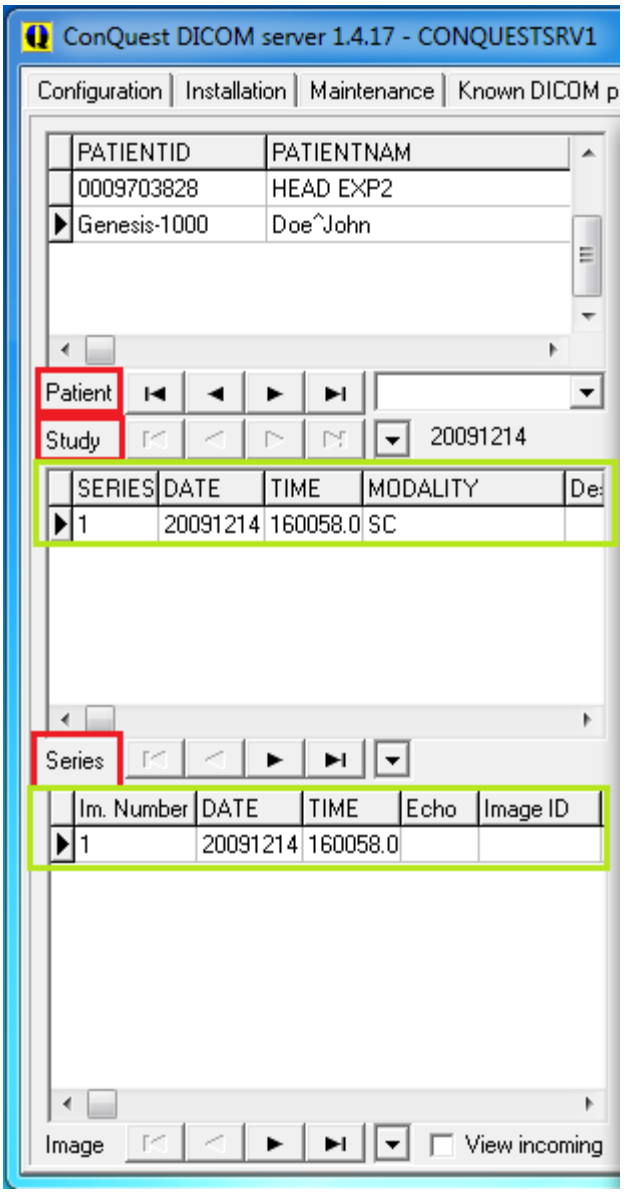
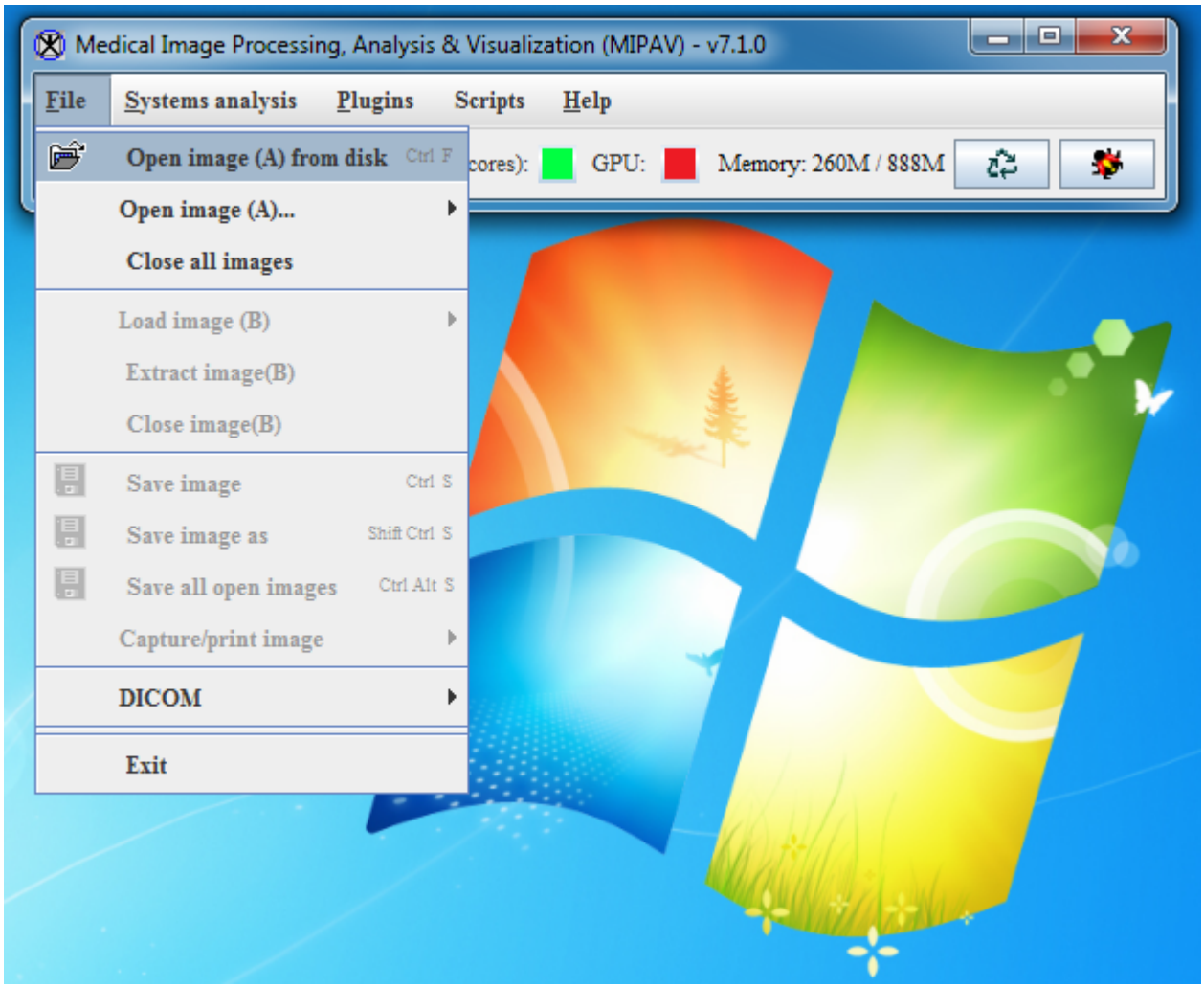
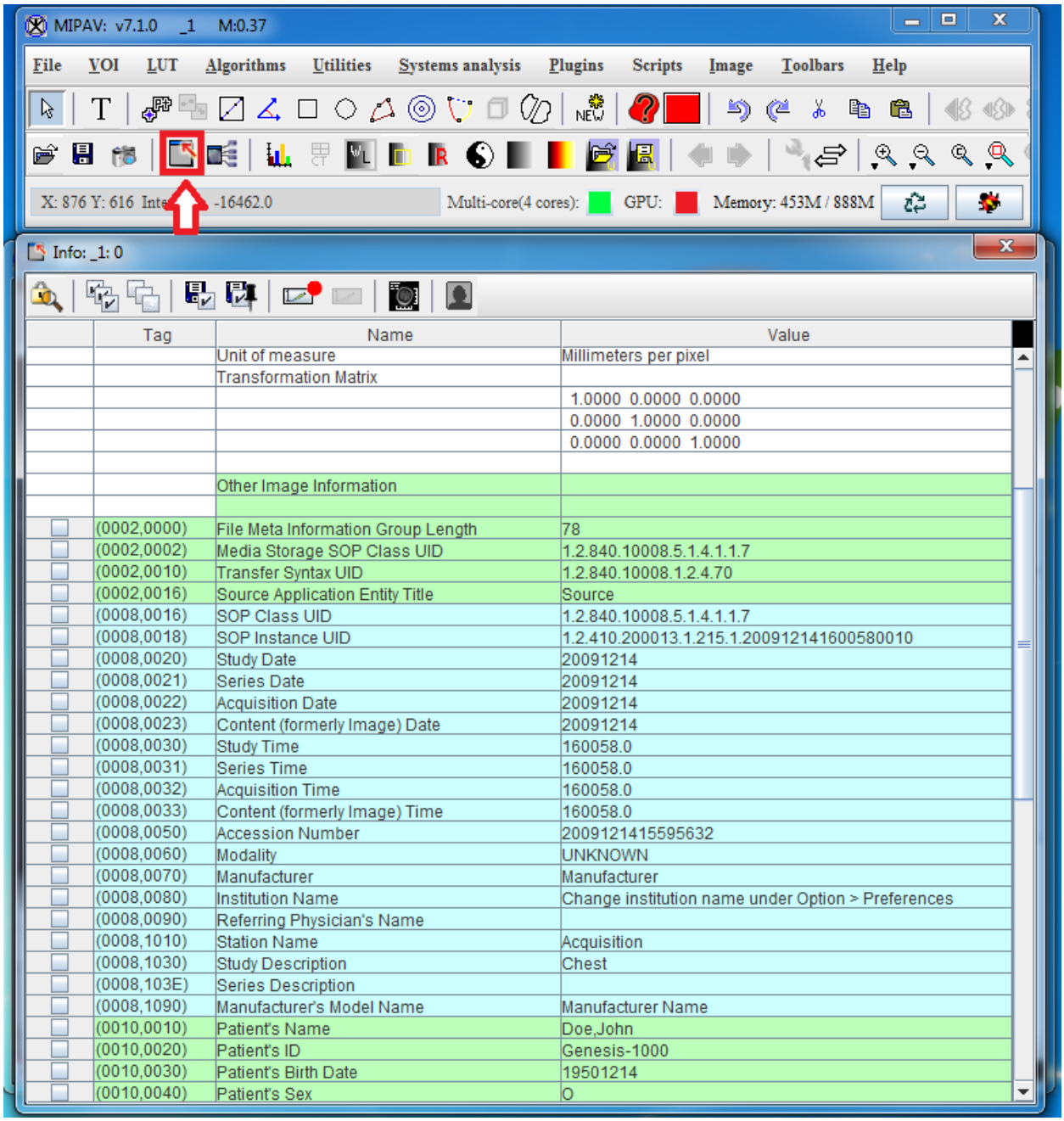


Figure 4-23 where meta data are kept

Curiosity kills the cat!

Now we want to see if it is possible to extract metadata from image with in MIPAV? The answer is yeas. Steps are shown in Fig. 4-24.





Tag	Name	Value
	Unit of measure	Millimeters per pixel
	Transformation Matrix	
		1.0000 0.0000 0.0000
		0.0000 1.0000 0.0000
		0.0000 0.0000 1.0000
	Other Image Information	
(0002,0000)	File Meta Information Group Length	78
(0002,0002)	Media Storage SOP Class UID	1.2.840.10008.5.1.4.1.1.7
(0002,0010)	Transfer Syntax UID	1.2.840.10008.1.2.4.70
(0002,0016)	Source Application Entity Title	Source
(0008,0016)	SOP Class UID	1.2.840.10008.5.1.4.1.1.7
(0008,0018)	SOP Instance UID	1.2.410.200013.1.215.1.200912141600580010
(0008,0020)	Study Date	20091214
(0008,0021)	Series Date	20091214
(0008,0022)	Acquisition Date	20091214
(0008,0023)	Content (formerly Image) Date	20091214
(0008,0030)	Study Time	160058.0
(0008,0031)	Series Time	160058.0
(0008,0032)	Acquisition Time	160058.0
(0008,0033)	Content (formerly Image) Time	160058.0
(0008,0050)	Accession Number	2009121415595632
(0008,0060)	Modality	UNKNOWN
(0008,0070)	Manufacturer	Manufacturer
(0008,0080)	Institution Name	Change institution name under Option > Preferences
(0008,0090)	Referring Physician's Name	
(0008,1010)	Station Name	Acquisition
(0008,1030)	Study Description	Chest
(0008,103E)	Series Description	
(0008,1090)	Manufacturer's Model Name	Manufacturer Name
(0010,0010)	Patient's Name	Doe,John
(0010,0020)	Patient's ID	Genesis-1000
(0010,0030)	Patient's Birth Date	19501214
(0010,0040)	Patient's Sex	O

Figure 4-24 Metadata within image is extracted via MIPAV

MIPAV shows the meta-data in color coded fashion. It is exactly in accordance with what Conquest DICOM server showed up.

The next question is where exactly the data are? We already mentioned that meta-data is in database and image files are in folder. So, lets try to locate them and see how they actually are stored.

First go to the folder which is defined as local storage image files for conquest server[8]. For each incoming image a new folder is made with in this directory and images are kept within their own dedicated folder. For example, our image is saved in *Genesis-100* folder (Figure 4-25). Within this folder image file is kept under a very long cryptographic code name! For further discussion about the naming convention the reader is referred to DICOM documentations.

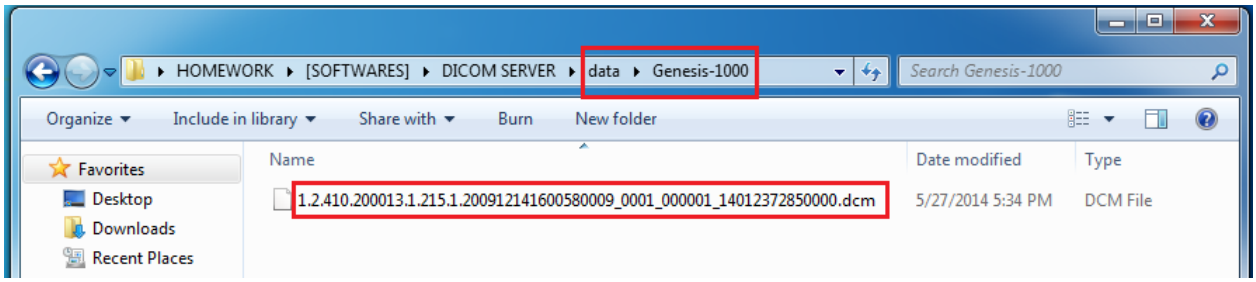
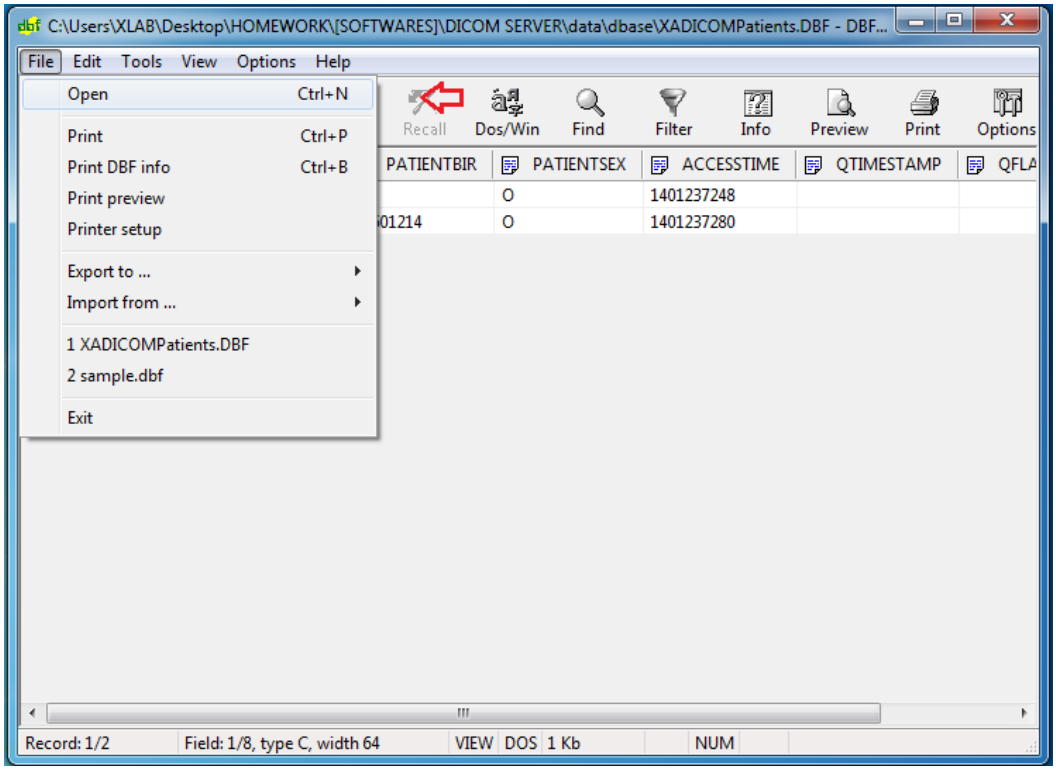
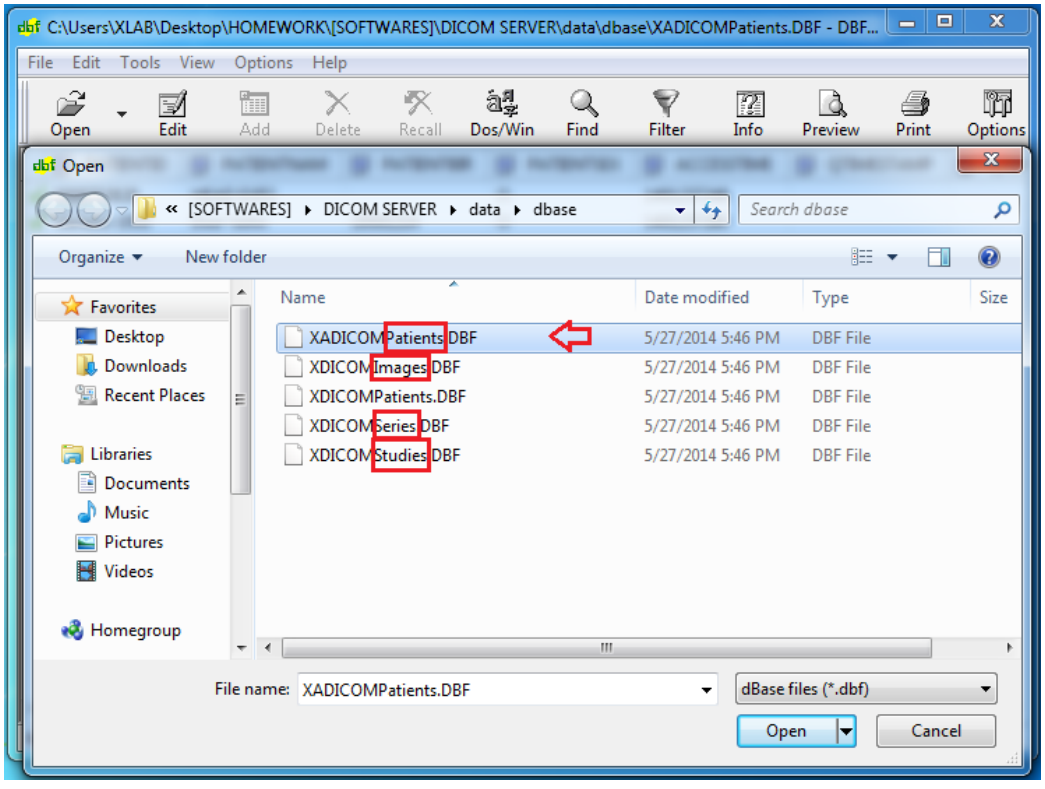


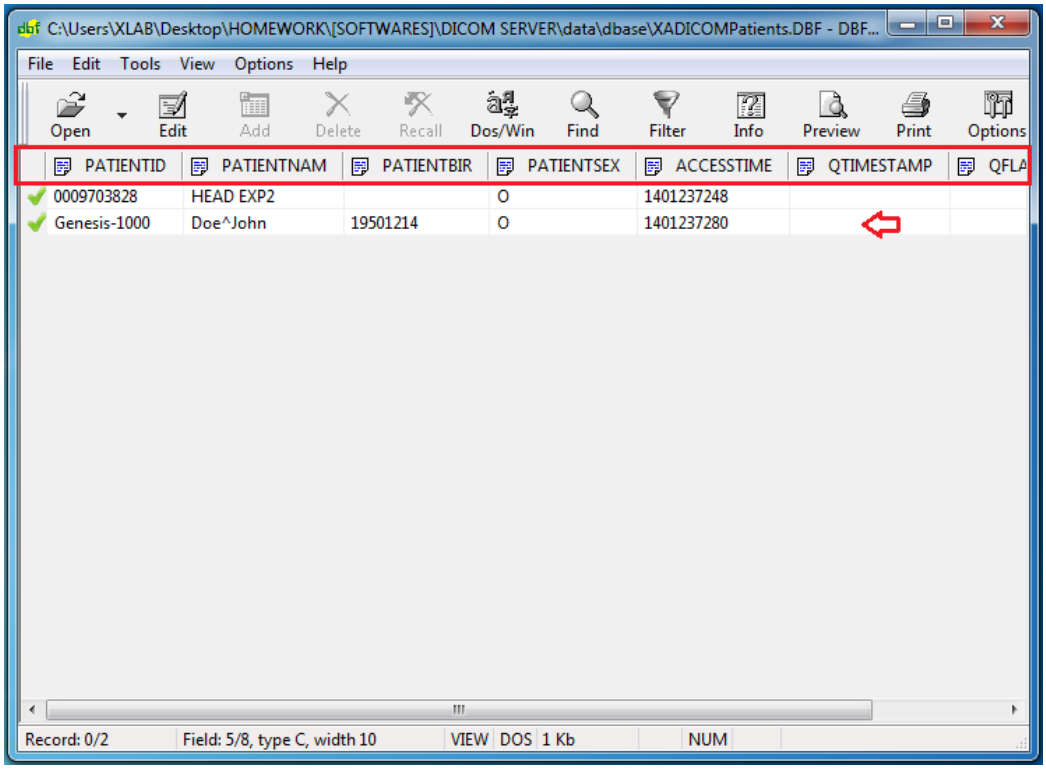
Figure 4-25 How physically images are saved in conquest DICOM

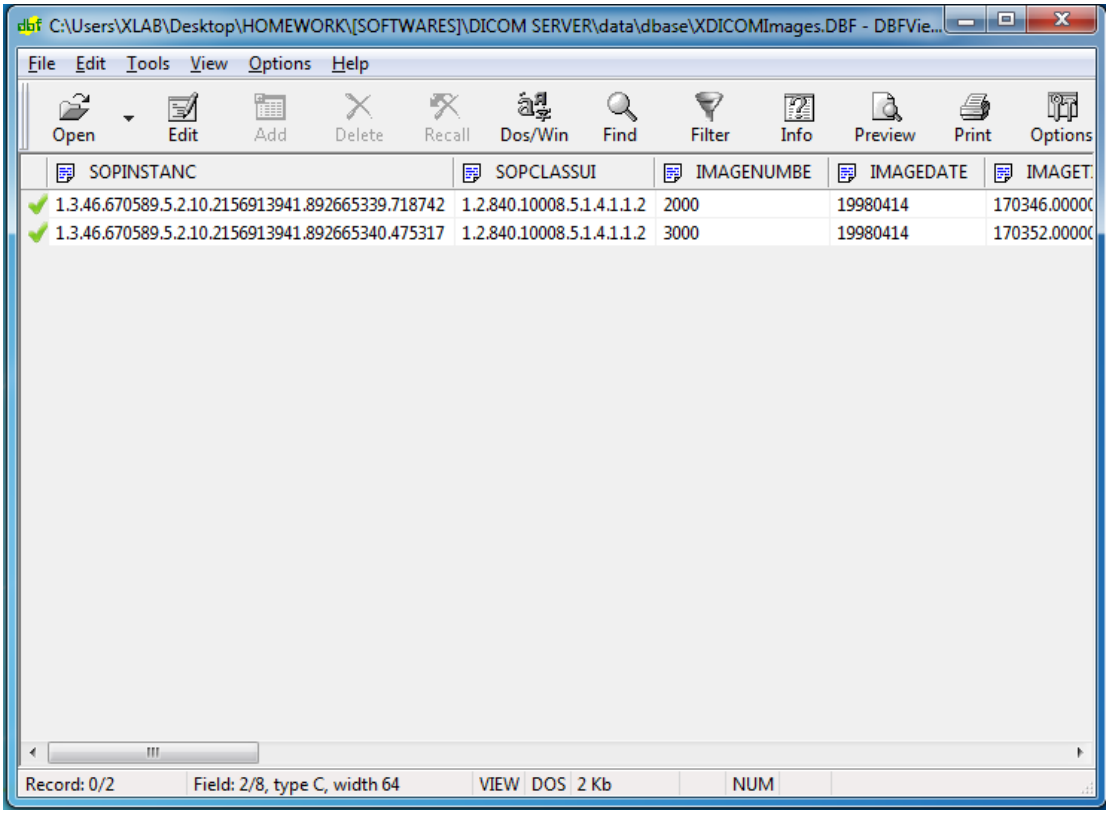
Finally, let's see how meta-data are stored in conquest database. In our SQL-Lite implementation, data is stored within DBF files inside *...\data\dbase* folder. To open this file extension we used DBFView. Complete picture of this process is given in Fig. 4-26

[8] Remember the configuration tab (Fig. 4-7)


C:\Users\XLAB\Desktop\HOMEWORK\[SOFTWARES]\DICOM SERVER\data\dbase\XADICOMPatients.DBF - DBF...
File Edit Tools View Options Help
Open Ctrl+N
Print Ctrl+P
Print DBF info Ctrl+B
Print preview
Printer setup
Export to ...
Import from ...
1 XADICOMPatients.DBF
2 sample.dbf
Exit
Recall Dos/Win Find Filter Info Preview Print Options
PATIENTBIR PATIENTSEX ACCESSTIME QTIMESTAMP QFLA
O 1401237248
01214 O 1401237280
Record: 1/2 Field: 1/8, type C, width 64 VIEW DOS 1 Kb NUM


C:\Users\XLAB\Desktop\HOMEWORK\[SOFTWARES]\DICOM SERVER\data\dbase\XADICOMPatients.DBF - DBF...
File Edit Tools View Options Help
Open Edit Add Delete Recall Dos/Win Find Filter Info Preview Print Options
Open
[SOFTWARES] ▸ DICOM SERVER ▸ data ▸ dbase
Search dbase
Organize New folder
Favorites
Desktop
Downloads
Recent Places
Libraries
Documents
Music
Pictures
Videos
Homegroup
Name Date modified Type Size
XADICOMPatients.DBF 5/27/2014 5:46 PM DBF File
XDICOMImages.DBF 5/27/2014 5:46 PM DBF File
XDICOMPatients.DBF 5/27/2014 5:46 PM DBF File
XDICOMSeries.DBF 5/27/2014 5:46 PM DBF File
XDICOMStudies.DBF 5/27/2014 5:46 PM DBF File
File name: XADICOMPatients.DBF
dBase files (*.dbf)
Open Cancel


C:\Users\XLAB\Desktop\HOMEWORK\[SOFTWARES]\DICOM SERVER\data\dbase\XADICOMPatients.DBF - DBF...
File Edit Tools View Options Help
Open Edit Add Delete Recall Dos/Win Find Filter Info Preview Print Options
PATIENTID PATIENTNAM PATIENTBIR PATIENTSEX ACCESSTIME QTIMESTAMP QFLA
0009703828 HEAD EXP2 O 1401237248
Genesis-1000 Doe^John 19501214 O 1401237280
Record: 0/2 Field: 5/8, type C, width 10 VIEW DOS 1 Kb NUM


C:\Users\XLAB\Desktop\HOMEWORK\[SOFTWARES]\DICOM SERVER\data\dbase\XDICOMImages.DBF - DBFVie...
File Edit Tools View Options Help
Open Edit Add Delete Recall Dos/Win Find Filter Info Preview Print Options
SOPINSTANC SOPCLASSUI IMAGENUMBE IMAGEDATE IMAGET
1.3.46.670589.5.2.10.2156913941.892665339.718742 1.2.840.10008.5.1.4.1.1.2 2000 19980414 170346.00000
1.3.46.670589.5.2.10.2156913941.892665340.475317 1.2.840.10008.5.1.4.1.1.2 3000 19980414 170352.00000
Record: 0/2 Field: 2/8, type C, width 64 VIEW DOS 2 Kb NUM

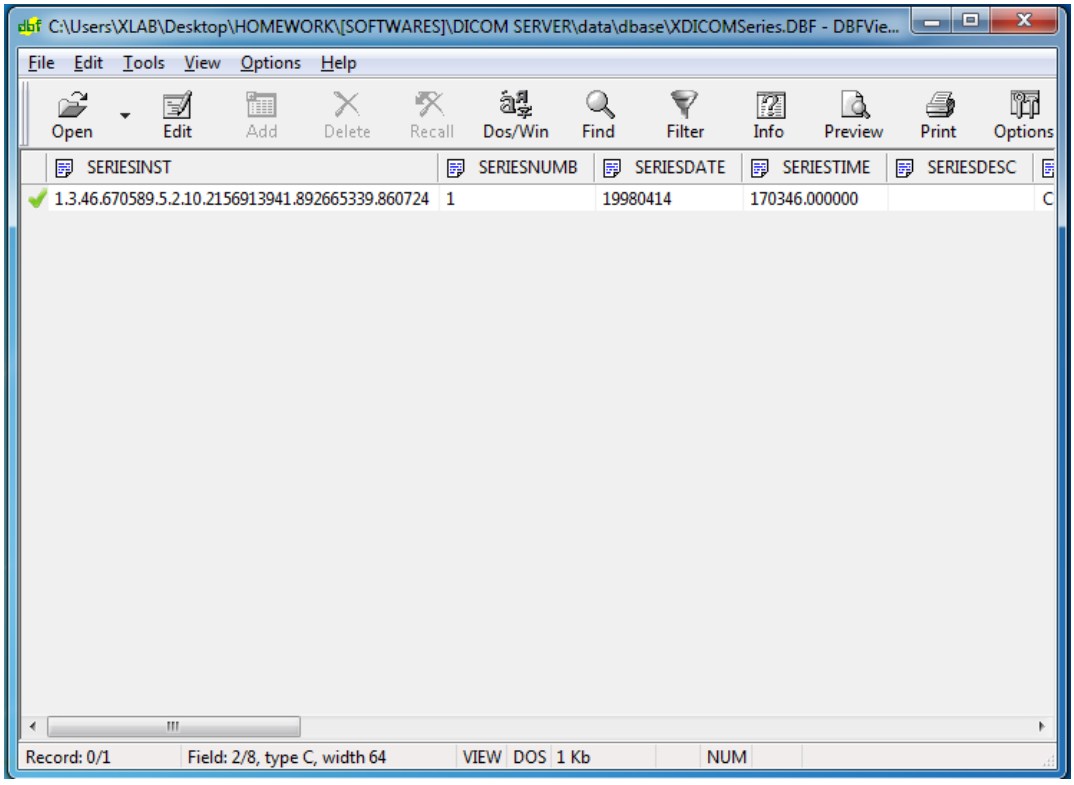
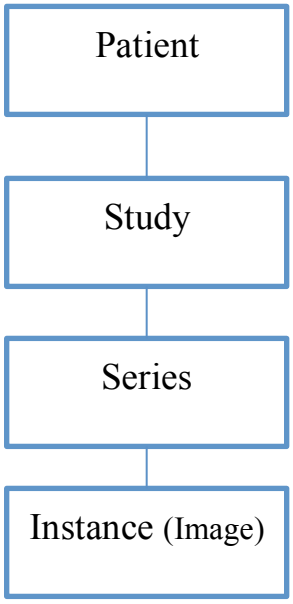


Figure 4-26 DBFView of database

Appendix DICOM Data Model[9]

The specification of DICOM objects are documented in chapter 3 of the DICOM standard that defines the DICOM data model. In its most simplified form the DICOM Data Model looks like this.



The data model defines Information Entities (IE's); Patient, Study, Series and Image. There are more IE's like Visit, Equipment, Clinical Trial, Procedure and many others and they are all defined in chapter 3 which is the longest chapter of the standard. The DICOM Data Model that is made of IE's is normalized. It is a perfect relational database definition. The classes of the DICOM Objects however are composites made of modules from different entities. The integration is achieved by applications that exchange composite objects between one another. Each application is responsible for it's own internal normalized database that is private to itself and should not interest any other application and is out of the standard's scope. The way you build your DICOM application internals is completely your business. The only thing that matters is your interfaces. Your application should talk proper DICOM. By the way, the DICOM network protocol that we'll get to in later chapters also makes a distinction between Normalized and Composite operations and there's N protocol and C protocol with different commands for each one.

[9] Content of this section is from http://dicomiseasy.blogspot.com.tr/

The classes of the DICOM static data model are called SOP Classes and are defined by IOD’s – Information Object Definition. IOD’s are specified in Appendix A of chapter 3 of the standard. An IOD is a collection of Modules and a Module is a collection of elements from one information entity that together represent something. The modules are also defined in chapter 3 of the DICOM standard in appendix C. Two object oriented concepts, composition and reuse, that are used by DICOM is the Modules that are parts shared between different IOD’s.

All DICOM Objects must include the SOP Common Module and modules from the four main IE’s: Patient, Study, Series and Image (Image and Instance are the same in DICOM. Once there were only images but then objects that are not images has been defined and the name thus changed from Image to Instance in order to represent an instance of a SOP class). All DICOM Images, that is DICOM Instances that Are Images, must include the Image Module. Because Every DICOM Object must be part of a Series, all DICOM Objects must include the General Series Module and because all series must be part of a Study, every DICOM Object must include the General Study Module and because every study is made on some patient, all DICOM objects must have a Patient Module. You probably wonder what SOP means? That's an acronym for "Service Object Pair" and please take my word for it, that for now this is all we need to say about that. Maybe when we talk about DICOM Services or understanding DICOM Conformance Statements I'll try to explain where this name comes from, but I'm not sure that it makes much difference. In a word, SOP is a pair of a DICOM Sevice and and DICOM Object like Secondary Capture Object and Storage Service.

5. References

1- Windows User manual Conquest DICOM Server version release 1.4.17
2- MIPAV User's guide, volume 1
3- http://dicomiseasy.blogspot.com.tr/
4- http://en.wikipedia.org/wiki/DICOM