

dcm4che Media and Network Applications

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covers *dcm4che* version 1.0.3

This manual describes how to use the sample applications of the *dcm4che* library as PACS communication tools for the ImageJ framework.

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1 Getting Started

1.1 Installation

Install *ImageJ* and the “*DICOM Import and Export Plugins*” as described in the accompanying manual. The installation directory will be referenced in the following as `<IMAGEJ_HOME>`.

The standard installation leads to a Java 1.4 JRE and a subdirectory `<IMAGEJ_HOME>/lib` with the following library files:

File/Directory	Description
dcm4che.jar	The dcm4che library.
log4j.jar	The logger used by dcm4che.
links.txt	A list of links to obtain the source code and other information to the libraries.

Download the media and network support archive. Unzip the `medianet.zip` file to `<IMAGEJ_HOME>`. You will receive the new directory `medianet` including the following files:

File/Directory	Description
dcmdir_a.bat	A dummy batch file to add file references.
dcmdir_c.bat	A dummy batch file to create a file-set.
dcmdir_x.bat	A dummy batch file to remove file references.
dcmdir_z.bat	A dummy batch file to compact a file-set.
dcmdir.cfg	The configuration file containing the default properties of dcmdir.
dcmdir.jar	The dcmdir application.
dcmrcv_file.bat	A dummy batch file to start the server. Stores objects as files in <code>./tmp</code> .
dcmrcv_dir.bat	A dummy batch file to start the server. Stores objects in file-set <code>./tmp/DICOMDIR</code> .
dcmrcv.cfg	Configuration file containing the default properties of dcmrcv.
dcmrcv.jar	The dcmrcv application.
dcmrcv.key	A file containing security keys for dcmrcv.
dcmsnd.bat	A dummy batch file to send a file to a server.
dcmsnd_echo.bat	A dummy batch file to test the connection with DICOM Echo.
dcmsnd.cfg	Configuration file containing the default properties of dcmsnd.
dcmsnd.jar	The dcmsnd application.
dcmsnd.key	A file containing security keys for dcmsnd.
/doc	The directory containing documentation files: <code>manual.pdf</code> – This manual as PDF file. <code>manual.rtf</code> – This manual as Rich Text File.
getopt.jar	A library for command-line options used by all applications.
log4j.properties	Property file for the log4j logger used by dcm4che.
SMPTE	A sample DICOM image.
/tmp	A directory for temporary files used by the dummy batch files: <code>SMPTE2</code> - A sample DICOM image.

2 Example Scenario

In the DICOM network communication context each node is defined by three information usually provided by the manufacturer:

1. The application entity title (AET)
2. The internet protocol (IP) address
3. The port number

To exchange information between two nodes, both must know from each other. Therefore each node has a list of possible communication partners. Typically you have to ask your equipment manufacturer to enter the three information of a new DICOM node to this list.

In the following it is explained how to send an image from a modality (e.g. MR imager) to a workstation, postprocess the image using ImageJ and store the result into a PACS archive. The workflow is shown on the diagram on the next page.

	Application Entity Title	IP Address	Port Number	Patient ID	Patient Name	Study ID	Series Number	Instance Number
Modality	SCANNER	192.168.0.5	5104					
Archive	ARCHIVE	192.168.0.6	7120					
dcmrcv	DCMRCV	192.168.0.7	104					
dcmsnd	DCMSND	192.168.0.8	104					
Image				1234567890	Test	29	17	1

First we have to create an empty DICOMDIR in the file-set. In the example the DICOM file-set should be stored in the directory `./tmp`:

```
java -jar dcmdir.jar -c ./tmp/DICOMDIR
```

Next the image server has to be started:

```
java -jar dcmrcv.jar --dest=./tmp/DICOMDIR 104
```

Now the image may be send from the modality to the image server. The image is stored in the file-set at `./tmp/TEST/29/17/1` and an entry in DICOMDIR is made.

Start ImageJ and import the received image using the Dcm_Import plugin. Use the DICOMDIR-Tab to select the image.

Process the image.

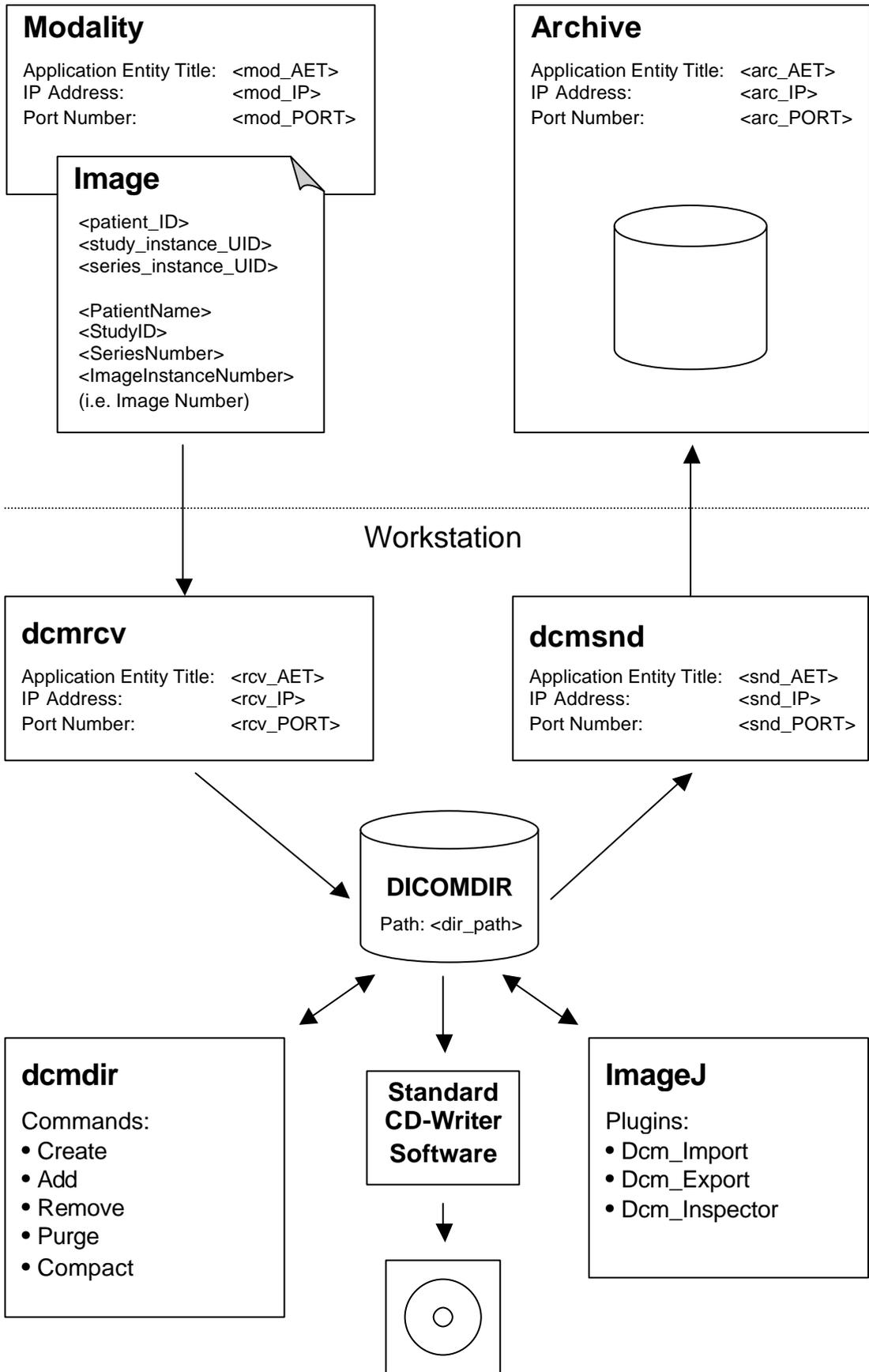
Export the processed image to the file-set using the Dcm_export plugin. Use the DICOMDIR-Tab to select the file-set as destination.

Send the image to the archive:

```
java -jar dcmsnd.jar dicom://ARCHIVE:DCMSND@192.168.0.6:7120 ./tmp/TEST/29/17/1
```

Delete the image (and all other images of the patient) in the file-set:

```
java -jar dcmdir.jar -X ./tmp/DICOMDIR --pat 1234567890 ./tmp
java -jar dcmdir.jar -z ./tmp/DICOMDIR
```



3 Applications

3.1 General

In the following files and directories may be referenced either by an absolute or a relative reference. A relative reference is relative to the current directory and starts with the string `./`. The parent directory is referenced by `../`. The path delimiter is independent of the operating system the character `/`. References not starting with a `.` are absolute. On systems running under a Windows OS these references start with the drive letter, e.g. `C:/tmp/foo.dcm`. On Linux systems they start with a `/`, e.g. `/tmp/foo.dcm`.

3.2 dcmdir

This application processes DICOM file-sets, as described in part 10 of the DICOM standard. Keep in mind, that DICOM restricts possible file-names: A file-set must contain one file, with name `DICOMDIR`, that contains information concerning the file-set. You can only add files to a file-set, which are stored in the directory of the `DICOMDIR` file or in sub-directories up to eight levels. The name of such files and directories may only be 8 characters long and the characters must be capital letters or numbers. The character `'.` is not allowed.

Using standard CD-writing software it is possible to create a DICOM-CD. Just write the whole contents of the directory containing the `DICOMDIR` file and all its subdirectories to a CD.

Examples:

```
java -jar dcmdir.jar -c ./tmp/DICOMDIR
```

Creates an empty file-set in the subdirectory `tmp`.

```
java -jar dcmdir.jar -a ./tmp/DICOMDIR ./tmp/SMPTE2
```

Adds the existing DICOM object `./tmp/SMPTE2` to the existing file-set `./tmp/DICOMDIR`.

```
java -jar dcmdir.jar -x ./tmp/DICOMDIR --pat 1234567890 ./tmp
```

Marks in the file-set `./tmp/DICOMDIR` all entries as *“not in use”*, if the referenced files are in directory `./tmp` or its subdirectories and have a patient ID equal to `1234567890`.

```
java -jar dcmdir.jar -P ./tmp/DICOMDIR
```

Marks in the file-set `./tmp/DICOMDIR` all entries as *“not in use”*, if the referenced files are not physical present at the referenced position in the filesystem.

```
java -jar dcmdir.jar -z ./tmp/DICOMDIR
```

Removes all entries in the file-set `./tmp/DICOMDIR` which are marked as *“not in use”*.

Usage:

```
java -jar dcmdir.jar -{tcaxXzP} dir-file [OPTION]... [FILE]...
```

Command:

```
-c dir-file create new DICOMDIR file with references to files...
-a dir-file add file references to existing DICOMDIR file
-x dir-file remove record(s) from existing DICOMDIR, with specified
  --pat id Patient ID
  --study uid Study Instance UID
  --series uid Series Instance UID
  --sop uid SOP Instance UID
  [FILE]... referenced files
-X dir-file same as -x dir-file, but also deletes referenced files
-P dir-file purge records from existing DICOMDIR file, with referenced
  files do not exist anymore
-z dir-file compact existing DICOMDIR file by removing inactive records
```

Options (override presets defined in resource dcmdir.cfg):

```
--id id defines File-set ID of created DICOMDIR file
--uid uid defines SOP Instance UID of created DICOMDIR file
--readme readme-file add README file reference to created DICOMDIR file
--readme-charset code specifies character set used in README file
--groupflen encode with (gggg,0000) group length attributes
--seqflen encode sequence attributes with explicit length
--itemlen encode sequence items with explicit length
--onlyInUse hide inactive records in content list
--maxlen line-len maximal line length in listing; default=79
--vallen val-len displayed value length in listing; default=64
--help display this help and exit
--version output version information and exit
```

3.3 dcmrcv

This application implements a DICOM server listening on `PORT`. It acts as a *Storage SCP*. The received images are stored to the local file-system or in a DICOM file-set, depending on the `dest` option. If the destination is a file-set, the received objects are stored in subdirectories of the file-set directory. The names of the subdirectories are derived from the received object: `PatientName`, `StudyID` and `SeriesNumber`. The name of the file the object is stored is the `InstanceNumber`. This behavior may be configured by the `fs-file-id` option.

Example:

```
java -jar dcmrcv.jar --dest=./tmp 104
```

Starts the server, listening on port 104. The received DICOM objects are stored as plain files in the subdirectory `tmp`.

Usage:

```
java -jar dcmrcv.jar [OPTION]... PORT
```

Options (override presets defined in resource dcmrcv.cfg):

```
--called-aets=AET1,.. only association requests with matching called and
--calling-aets=AET1,.. calling AET will be accepted
--max-pdu-len=LEN set maximal length of receiving PDUs [default=16352]
--max-op-invoked=NUM set maximal number of invoked operations with
  outstanding response
```

```

--rsp-delay=SEC      define additional delay of response
                    (useful for testing async mode)
--dest=DEST         if DEST specifies a DICOMDIR file path (=last
                    component = "DICOMDIR"), the received objects will
                    be stored as DICOM File-set, further specified by
--fs-id=NAME        the File-set Identifier [default=<none>],
--fs-uid=UID        the File-set SOP Instance UID [default=<auto>],
--fs-file-id=TAG_PATH specifies schema for generated file IDs [default=
                    StudyDate,StudyID,SeriesNumber,InstanceNumber],
--fs-lazy-update    defer update of DICOMDIR at association release,
                    instead immediately at each object receipt.
--set=TAG:VAL       Replace value of specified attribute with
                    specified value in received object
                    (e.g.: --set=PatientName:anonymous).
--buf-len=LEN       set length byte buffer, used to store data to file
--tls=CIPHERSUITE1,.. accept TLS connection with specified Cipher Suites
                    eg.: SSL_RSA_WITH_NULL_SHA,
                        SSL_RSA_WITH_3DES_EDE_CBC_SHA
--tls-key=KEYSTORE  get key from specified resource [default:dcmrcv.key]
--tls-key-passwd=PASS password for keystore and key specified by --tls-key
                    [default: dcm4che]
--tls-cacerts=KEYSTORE read trusted CA Certificats from specified resource
                    [default:cacerts]
--tls-cacerts-passwd=PASS password for keystore specified by --tls-cacerts
                    [default: dcm4che]
--help             display this help and exit
--version          output version information and exit

```

3.4 dcmsnd

This application send DICOM objects to an *Storage SCP*, e.g. an archive. It acts as a *Storage SCU*. The objects are read from the local file-system and are send to an *Storage SCP* which is defined by URL. FILE may be the name of a single file, a list of files separated by whitespaces or the name of a directory. In the later case all files in the directory and all subdirectories are send. If FILE is omitted, the connection to the remote node will be verified by DICOM Echo.

Examples:

```
java -jar dcmsnd.jar dicom://DCMRCV:DCMSND@localhost:104 ./SMPTE
```

Opens association to local server, listening on port 104, with calling application entity title DCMSCND and called application entity title DCMRCV. Sends the DICOM file ./SMPTE to the server.

```
java -jar dcmsnd.jar dicom://DCMRCV:DCMSND@localhost:104
```

Opens association to local server, listening on port 104, with calling application entity title DCMSCND and called application entity title DCMRCV. Verifies the connection with DICOM Echo.

Usage:

```
java -jar dcmsnd.jar [OPTION]... URL [FILE]...
```

Url:

```
dicom://CALLED[:CALLING}@HOST[:PORT]
  CALLED      Called AET in association request
  CALLING     Calling AET in association request [default=ANONYMOUS]
```

HOST Name or IP address of host, where the server is running
PORT TCP port address, on which the server is listening for
incoming TCP Transport Connection Indication [default=104]

Options (override presets defined in resource dcmsnd.cfg):

--prior-high HIGH priority of storage requests [default=NORMAL]
--prior-low LOW priority of storage requests [default=NORMAL]
--max-pdu-len=LEN set maximal length of receiving PDUs [default=16352]
--max-op-invoked=NUM set maximal number of invoked operations with
outstanding response [default=0 -> unlimited]
--max-pdu-len=LEN maximal length of receiving PDUs [default=16352]
--buf-len=LEN byte buffer length, used to store data to file
[default=2048]
--repeat-dimse=NUM Number of times to repeat single request [default=1]
--repeat-assoc=NUM Number of times to repeat whole operation [default=1]
--buf-len=LEN set length byte buffer, used to store data to file
--set=TAG:VAL Replace value of specified attribute with
specified value in transmitted object
(e.g.: --set=PatientName:anonymous).
--tls=CIPHERSUITE1,.. accept TLS connection with specified Cipher Suites
eg.: SSL_RSA_WITH_NULL_SHA,
SSL_RSA_WITH_3DES_EDE_CBC_SHA
--tls-key=KEYSTORE get key from specified resource [default:dcmsnd.key]
--tls-key-passwd=PASS password for keystore and key specified by --tls-key
[default: dcm4che]
--tls-cacerts=KEYSTORE read trusted CA Certificats from specified resource
[default:cacerts]
--tls-cacerts-passwd=PASS password for keystore specified by --tls-cacerts
[default: dcm4che]
--poll-dir=DIR Poll the specified directory for DICOM files - e.g.
received by application dcmrcv - and forward them
to the remote DICOM node. [default: <none>]
--poll-period=PERIOD Poll period in s. The default is 5s.
--poll-retry-open=TIME Retry open connection to remote host with specified
time interval. The default is 60s.
--poll-delta-last-modified=TIME Only consider files, which modification time
differs with the current time more than the specified
value. The default is 3s.
--poll-done-dir=DIR Moves sent files to the specified directory, instead of
removing it from poll-dir.
--help display this help and exit
--version output version information and exit

4 References

The ImageJ framework: <http://rsb.info.nih.gov/ij/>

The dcm4che project homepage: <http://sourceforge.net/projects/dcm4che/>

The DICOM normative text: <http://www.dclunie.com/>