Radiology Module with DCM4CHEE

Install Guide

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Introduction

This install guide consists of four essential components for the entire module to function properly.

- **OpenMRS Radiology Module** – Module to place orders/worklists in dcm4chee and reflect the status of the order. Physicians can add radiology orders and specialists can add observations based on the procedure performed. Orders added are stored as modality worklists in dcm4chee.

- **DCM4CHEE** - A DICOM image and archive manager which can be used as a PACS(Picture Archiving and Communication System) when coupled with a viewer. Also provides features to add modality worklists and update the status of the worklists based on the MPPS(Modality Performed Procedure Step) status messages and forward the status messages to OpenMRS.

- **Oviyam/Weasis** – DICOM Image Viewer. Oviaym 2.0 is a HTML5 Javascript based DICOM image viewer whereas Weasis is a standalone Java based DICOM image viewer.

- **Dvtk Modality Emulator** – Emulator to simulate modality functions based on the DICOM standard. Communicates with dcm4chee to retrieve worklists, inform dcm4chee of the status of an initiated procedure and store the images when procedure is completed.
OpenMRS Radiology Module

Installation

- Install the Radiology Module OMOD
  - Download: [https://github.com/openmrs/openmrs-module-radiologydcm4chee](https://github.com/openmrs/openmrs-module-radiologydcm4chee)
  - In 
    "(module folder)/omod/target": The latest omod will be available.
  - To build again from source, run “mvn clean install” inside the module root folder.

- In the Administration Page,
  - There will be a new section called Radiology Module.
  - Manage Radiology Orders:
    - Referring Physicians can
      - Add orders.
      - View all Radiology orders in the system.
      - Edit orders.
    - Schedulers can schedule the appropriate time for the study (exam) to be performed.
    - Performing Technicians can view orders and update current status of the radiology order.
    - Reading Physicians can
      - View Completed orders with links to launch image viewer.
      - Add observation on the radiology study performed.
  - Configuration and Initialization (Optional: Need not be used if the module started correctly)
    - If module started correctly, a new Order Type called ‘Radiology’ can be found in Administration→Orders→Manage Order Types
    - If module started correctly, new Roles called ‘Scheduler’, ‘Performing Technician’, ‘Reading Physician’, ‘Referring Physician’ can be found in Administration→Users→Manage Roles
    - If not, Click on the “Create Radiology Order Type and Roles required by the module” link.
    - If new user needs to be created, click on the “Create Dummy Users” link.
Admin | Manage Radiology Orders

Configuration and initializaion

Create radiology order type and roles required by the module (Optional)
Create dummy users (Optional)

Saving
AWL entries in: C:\OpenMRS1.9.x\openmrs-core\webapp\xml
MPPS entries in: C:\OpenMRS1.9.x\openmrs-core\webapp\mpps
OpenMRS Radiology Module

Order Type Management

Add Order Type

Current Order Types

- Drug order
- Lab test
- X-ray/CT/MRI
- Radiology

Delete Selected Order Types

Role Management

Add Role

Current Roles

- Anonymous
- Provider
- Radiology: Performing Technician
- Radiology: Reading Physician
- Radiology: Referring Physician
- Radiology: Scheduler
- System Developer

Inherited Roles

- View Navigation Menu
- View Relationships
- View Privileges
- Add new User
- Create New User
- View User
- Change User
- Delete User
- Change Password
- Change User Role
- Change User Privileges
- Change User Access
- Change User Location
- Change User Contact Information
- Change User Address
- Change User Phone
- Change User Email
- Change User Notes
- Change User Status
- Change User Image
- Change User Language
- Change User Timezone
- Change User Currency
- Change User Time
- Change User Date
- Change User Week
- Change User Month
- Change User Year
- Change User Decade
- Change User Century
- Change User Millenium
- Change User Calendar
- Change User Timezone
- Change User Currency
- Change User Time
- Change User Date
- Change User Week
- Change User Month
- Change User Year
- Change User Decade
- Change User Century
- Change User Millenium
- Change User Calendar

Privileges

- System Developer
- [has all roles and privileges]

Delete Selected Roles
Module Properties/Settings

- **Goto Administration** → **Maintainence** → **Settings** → **Radiology**
  - **Application Entity Title** is the application entity title of the radiology module which is used by dcm4chee to forward status updates of various studies (radiology orders). This has to be identical to the Application Entities mentioned in the Application Entities Console of the dcm4chee Web Application. It should also be the Application Entity mentioned in the forwarding rules of the MPPSScu service in the JMX-Console.
  - **Called Application Entity Title** is the application entity title of dcm4chee which is used for communication which is DCM4CHEE by default.
  - **Mwl MPPS Port** is the port the Radiology Module is listening to for status updates from dcm4chee.
  - **Oviyam Local Server Name** is the ‘Server Description’ of the dcm4chee server in Oviyam’s settings. This has to be identical to the entry in the oviyam settings as its used to build the URL to view the image.
  - **Servers Address** is the ip address of the dcm4chee server. ‘localhost’ is the default value.
  - **Servers Port** is the port in which the web application of dcm4chee is accessed. This is the port through which images is accessed.
  - **Viewer URL Path** is the designated path for DICOM image viewer. Default set for Oviyam 2.0 but can be configured to Weasis as well.

- If any of the settings are changed in Radiology Settings, the module needs to be restarted for the new settings to take effect.
User Privileges

- The new roles added to the system inherit properties from the default role ‘Provider’ as well as their privileges.
- The privileges needed by users/roles using the module are:
  - Add, Edit, Delete, View Orders.
  - Add, Edit, Delete, View Observations.
  - Patient Dashboard – View Radiology Section.
  - View Users.
  - View Encounters.
  - View Concepts.
  - View Patients.
  - View Administration Functions.
IMPORTANT: Make sure the server has **Ownership and Write Permissions** to write files and folders. The module creates XML entries of each order in DICOM standard and MPPS DICOM files are written to disk when it receives MPPS status messages from DCM4CHEE.

**On Linux**

#Change ownership and permission for CATALINA_HOME and CATALINA_BASE

```bash
sudo chgrp -R tomcat6 /etc/tomcat6
sudo chmod -R g+w /etc/tomcat6
```

```bash
sudo chgrp -R tomcat6 /var/lib/tomcat6  # CATALINA_BASE
sudo chmod -R g+w /var/lib/tomcat6
```

**On Windows**

#User access control may restrict reading and writing of new files by the server

#To get around this, run the server as an administrator by Right Click on Tomcat-->Run as Administrator

#Or Run-->MSCONFIG-->Tools-->Disable UAP-->Launch
OpenMRS Installation Notes/Tips

- OpenMRS Standalone package comes with tomcat and mysql prepackaged.
- If installing Tomcat and MySql manually, these are some notes useful to help setup the environment quickly.

Tomcat Notes

### On Linux ###

*Install via Debian package on Ubuntu*

```
sudo apt-get install tomcat6
sudo apt-get install tomcat6-admin
```

/Add users and their roles to tomcat-users.xml

```
sudo vi /etc/tomcat/tomcat-users.xml
<user name="admin" password="admin" roles="tomcat,admin,manager,manager-gui"/>
```

/Turn off the Tomcat security flag

```
sudo vi /etc/init.d/tomcat6
TOMCAT6_SECURITY=no ##from yes to no
```

**IMPORTANT**

/Change ownership and permission for CATALINA_HOME and CATALINA_BASE

```
sudo chgrp -R tomcat6 /etc/tomcat6
sudo chmod -R g+w /etc/tomcat6
```

```
sudo chgrp -R tomcat6 /var/lib/tomcat6  # CATALINA_BASE
sudo chmod -R g+w /var/lib/tomcat6
```

/Create and provide appropriate permissions for OpenMRS properties folder in CATALINA_HOME

```
sudo mkdir /usr/share/tomcat6/.OpenMRS
sudo chown -R tomcat6:root /usr/share/tomcat6/.OpenMRS
```

/Restart the server

```
sudo /etc/init.d/tomcat6 restart
```

/Install manually from package

/Download the zip archive of Tomcat 6.0.29

/Unpack the zip file to a suitable location such as /opt on Linux or /Library on Mac OSX

/Add ownership and provide permissions for appropriate folders

```
sudo useradd tomcat6
cd /opt
sudo tar zxfv apache-tomcat-6.0.29.tar.gz
```
sudo ln -s apache-tomcat-6.0.29 tomcat6
sudo chown tomcat6.tomcat6 apache-tomcat-6.0.29

#Add users and their roles to tomcat-users.xml
sudo vi /etc/tomcat/tomcat-users.xml
<user name="admin" password="admin" roles="tomcat,admin,manager,manager-gui"/>

### Useful Linux commands ###
sudo find / -name "openmrs-runtime.properties"
netstat -tap
netstat -tln

### On Windows ###
#Use the Windows installer to install tomcat
#User access control may restrict reading and writing of new files by the server
#To get around this, run the server as an administrator by Right Click on Tomcat-->Run as Administrator
#Or Run-->MSCONFIG-->Tools-->Disable UAP-->Launch

### Deploy OpenMRS ###
#Add OpenMRS in tomcat manager
http://localhost:8080/manager/html
## Upload OpenMRS.war
#Run OpenMRS and upload module
http://localhost:8080/openmrs/index.htm

Mysql Notes

### On Linux ###
#Install using debian package
sudo apt-get install mysql-server
#Configure root password

# Stop/Start/Restart Mysql
sudo /etc/init.d/mysql start/stop/restart

### On Windows ###
#Use default windows installer and configure root password
DCM4CHEE

Installation

- **Requirements**: A supported database must be installed for dcm4chee. The list of supported databases are,
  - PostgreSQL 8.1+
  - MySQL 4.1+
  - Oracle 9i+
  - SQL Server 2000+
  - DB2 8.1+
  - Firebird 2.1+

  **Note**: This guide is based on MySQL 5.5


- For detailed instructions on installing dcm4chee:
  [http://www.dcm4che.org/confluence/display/ee2/Installation](http://www.dcm4che.org/confluence/display/ee2/Installation)

- Download the binary distribution for dcm4chee from sourceforge and extract it:
The below link is the binary for MySQL

- Download the binary distribution package of JBoss Application Server 4.2.3.GA:

- Copy files from JBoss to dcm4chee:
  - Dcm4chee consists of components that run within the JBoss application server platform. This step will copy the JBoss runtime files to the dcm4chee directory.
  - Go to the dcm4chee-2.17.1-xxx/bin directory and execute the install_jboss.bat or install_jboss.sh script, as appropriate for your operating system, with the path of your JBoss as installation directory as a parameter.
  - For example:
    - `C:\apps\dcm4chee-2.17.1-psql\bin>install_jboss.bat c:\apps\jboss-4.2.3.GA`

- Create the dcm4chee database

  - Create and initialize the dcm4chee database.

  - The file `create.mysql` can be found at `<installation folder>/dcm4chee-<x.xx.x>-mysql/sql/create.mysql`, where `<x.xx.x>` is the dcm4chee version number.

  - The file `create.mysql` contains SQL instructions that populate the database with empty tables.

    `> mysql -uroot -p<root password>`
mysql> create database pacsdb;
mysql> grant all on pacsdb.* to 'pacs'@'localhost' identified by 'pacs';
mysql> q
mysql> mysql -upacs -ppacs pacsdb < create.mysql

- Change Port for dcm4chee WebApp (optional)
  - Default port on which dcm4chee webapp is deployed is 8080.
  - To avoid clashes with the OpenMRS server, it is recommended to change the port.
  - Go to {install folder}\dcm4chee-2.17.1-mysql\server\default\deploy\jboss-web.deployer\server.xml
  - Change the connector port tag from port=8080 to a custom port.
  - Note: OpenMRS Standalone uses port 8081 by default.
  - IMPORTANT: The module depends on the port that is set here for viewing images. The value used by the module is 8081 by default. If you choose to use any other free port, remember to change the port in OpenMRS→Administration→Settings→Radiology→Servers Port
  - After saving the change in port value, you will need to restart the module.
  - (See figures below)
OpenMRS Radiology Module
Note: For MAC Users,

Because there are no native codecs (compression/decompression) for these platforms, it is necessary to edit configuration to disable the loading of the native codecs. These platforms are not able to take advantage of compression/decompression. The only default loading of the codecs is in the WADO service. You can either edit the property within the JMX Console web user interface, or edit the configuration files directly.

In \{install folder\}\dcm4chee-2.17.1-mysql\bin

Execute `run.bat` to start the server (`run.sh` in Linux)

(Ctrl-c to shut the server)

Login to dcm4chee from a browser at [http://localhost:8081/dcm4chee-web3](http://localhost:8081/dcm4chee-web3)

Login credentials User: admin Password: admin
User login at Akhil-PC

Username: akhil
Password: ********

Sign in  Reset
Setting Up Mpps Forwarding

- In a new tab, open http://localhost:8081/jmx-console/

- Search or navigate to ‘service=MppsScu’ and click on it
• Goto the ForwardingRules section and enter the entry.

\[\text{calling}! = \text{RADIOLOGY\_MODULE}]\text{RADIOLOGY\_MODULE}\]

And click ‘Apply Changes’ at the bottom of the table.

• IMPORTANT: The ‘RADIOLOGY\_MODULE’ Application Entity title corresponds to the Application Entity title in the module’s settings.

• IMPORTANT: The ‘MWL MPPS Port’ corresponds to the port of the ‘RADIOLOGY\_MODULE’ Application Entity in dcm4chee.
## OpenMRS Radiology Module

### Table of MBeans

<table>
<thead>
<tr>
<th>Property</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TopNoDelay</td>
<td>boolean</td>
<td>Send packets as quickly as possible (Disable Nagle algorithm).</td>
</tr>
<tr>
<td>SendBufferSize</td>
<td>int</td>
<td>Buffer size used for socket output. 0 = use platform default.</td>
</tr>
<tr>
<td>ReceiveBufferSize</td>
<td>int</td>
<td>Buffer size used for socket input. 0 = use platform default.</td>
</tr>
<tr>
<td>TLSConfigName</td>
<td>javax.management.ObjectName</td>
<td>List of forwarding rules, dependent upon which application - identified by the Calling AE title - sent the MPPS. The comma separated list of AE titles after the (optional) condition defines the forwarding destination (the other MPPS SCP) by its Called AE Title.</td>
</tr>
<tr>
<td>ForwardingRules</td>
<td>java.lang.String</td>
<td>List of forwarding rules, dependent upon which application - identified by the Calling AE title - sent the MPPS. The comma separated list of AE titles after the (optional) condition defines the forwarding destination (the other MPPS SCP) by its Called AE Title.</td>
</tr>
<tr>
<td>CallingAEName</td>
<td>java.lang.String</td>
<td>Calling AE Title used in the Association Request.</td>
</tr>
<tr>
<td>Concurrency</td>
<td>int</td>
<td>Maximum number of concurrent forwarded MPPS messages.</td>
</tr>
<tr>
<td>RetryIntervals</td>
<td>java.lang.String</td>
<td>Number and intervals of retries for failed MPPS forward requests.</td>
</tr>
<tr>
<td>QueueName</td>
<td>java.lang.String</td>
<td>Used internally. Do NOT modify.</td>
</tr>
<tr>
<td>IMSServiceName</td>
<td>javax.management.ObjectName</td>
<td>Used internally. Do NOT modify.</td>
</tr>
<tr>
<td>MppsSccServiceName</td>
<td>javax.management.ObjectName</td>
<td>Used internally. Do NOT modify.</td>
</tr>
</tbody>
</table>

### List of MBean operations:

- **void create()**
  - Standard MBean lifecycle method
  - `invoke`

- **void start()**
  - The start lifecycle operation
  - `invoke`

- **void stop()**
  - Standard MBean lifecycle method
Adding Radiology Module AET to dcm4chee

- Click on the “Application Entities” tab.
- Click on “New AET”
- Enter these details which are currently default in the module and click save.

- Title: RADIOLOGY_MODULE
- Host: localhost (or ip of where OpenMRS is deployed)
- Port: 11114
Notes about DCM4CHEE

- The default screens in the image archive and Worklist tabs are always empty.
- You will need to run a search to pull up relevant results.
- A search with no parameters will pull all the entries in the database.
- Resetting the search parameter and running the search will retrieve all entries.
OpenMRS Radiology Module
## OpenMRS Radiology Module

![Radiology Module Screenshot](image)

### Table: Radiology Results

<table>
<thead>
<tr>
<th>Patient Name</th>
<th>Date of Birth</th>
<th>SPS Description</th>
<th>Modality</th>
<th>SPS Status</th>
<th>Start Date</th>
<th>Station ALT</th>
<th>Station Name</th>
<th>Accession number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. John Doe</td>
<td>1/2/1975</td>
<td>MRI</td>
<td>MR</td>
<td>DISCONTINUED</td>
<td>5/27/2013 00:00</td>
<td>unknown</td>
<td>unknown</td>
<td></td>
</tr>
<tr>
<td>Dr. Jane Smith</td>
<td>4/3/1980</td>
<td>CT</td>
<td>CT</td>
<td>COMPLETED</td>
<td>6/27/2013 00:00</td>
<td>unknown</td>
<td>unknown</td>
<td></td>
</tr>
</tbody>
</table>

*Note: SPS stands for Scan Planning System.*
Oviyam

Installation

- Download the package from http://sourceforge.net/projects/dcm4che/files/Oviyam/2.0/Oviyam-2.0-bin.zip/download
- Extract the package and copy the war file in to
  \{install folder}\dcm4chee-2.17.1-mysql\server\default\deploy\n- Restart or start the server.
- **IMPORTANT**: Google Chrome is the recommended browser to use Oviyam.
- Oviyam can be viewed directly through the link http://localhost:8081/oviyam2/
- The login credentials are the same as dcm4chee
  User: admin Password: admin

Server Configuration

- Go to the Admin ➔ Settings
• Add the dcm4chee server configuration.
  o Description : oviyamlocal
  o AETitle: DCM4CHEE
  o Host: localhost {It is on the same ip address as dcm4chee}
  o Port: 11112
  o Retrieve Type : WADO
  o WADO Context: wado
  o WADO Port: 8081 {same as the dcm4chee-web3 port}
• Click the save button on the right and click Verify to check if all the settings are correct, if they are correct a green popup will display showing the verification was successful.
- The Home screen for oviyam should display the new server.
Oviyam Notes

- Click on the “oviyamlocal” tab and run an empty search (if there are any images).

Weasis

Installation

- Alternative Dicom viewer to Oviyam 2.0.
- Java Based DICOM image viewer. [http://www.dcm4che.org/confluence/display/WEA/Home](http://www.dcm4che.org/confluence/display/WEA/Home)
- Integrates within dcm4chee server.
- Requires JAVA Web Start to be installed/enabled to launch from the browser.
- Installation instructions [http://www.dcm4che.org/confluence/display/WEA/Installing+Weasis+in+DCM4CHEE](http://www.dcm4che.org/confluence/display/WEA/Installing+Weasis+in+DCM4CHEE)
- After the required WAR files have been deployed on the dcm4chee server, two of the module’s settings/properties need to be altered to launch Weasis from OpenMRS.
  - **Oviyam Local Server Name**: {leave empty}
  - **Viewer URL Path**: /weasis-pacs-connector/viewer.jnlp?
Modality Configuration

Configuration settings for Modalities

- **RIS System**
  - IP Address: localhost (IP address of dcm4chee server)
  - Remote Port: 11112
  - AE Title: DCM4CHEE

- **MPPS Manager**
  - IP Address: localhost (IP address of dcm4chee server)
  - Remote Port: 11112
  - AE Title: DCM4CHEE

- **PACS/Workstation Systems**
  - IP Address: localhost (IP address of dcm4chee server)
  - Remote Port: 11112
  - AE Title: DCM4CHEE

- **Store Commit Config**
  - IP Address: localhost (IP address of dcm4chee server)
  - Remote Port: 11112
  - AE Title: DCM4CHEE
Dvtk Modality Emulator

Installation

- **IMPORTANT:** This emulator is available only on Windows.
- Install the Modality Emulator from this link. 
- **IMPORTANT:** Install the DICOM definition files from this link before you run the emulator. 
  http://dicom.dvtk.org/modules/wiwimod/index.php?page=Download+DICOM+Definition+Files
- Run the emulator(there should be an icon for modality emulator in the start menu).
- **IMPORTANT : In the emulator, a file or setting is selected if the value is highlighted.
Configure the Emulator

- Click on the “Configure Remote Systems Button.”
  - The IP Address, Remote Port and AE Title are the same for all the different systems.
  - IP Address: localhost (or ip of dcm4chee server)
  - Remote Port: 11112
  - AE Title: DCM4CHEE

- Click on the Configure Emulator button, a number of tabs will be visible.
Click on the Worklist query Tab.
  - In the bottom left dialog box, choose the file “worklistquery2.dcm”.
  - In the right side where all the attributes are displayed, scroll down to the Code Meaning “Scheduled Procedure Step Start Date” and delete the value. (The worklistquery2.dcm is an empty query with only that field having a value).
  - Save the completely empty query to another file called “worklistquery4.dcm” and select it.
• In the Image Storage tab, select the images on the left panel using the directory structure for the imaged you wish to send. If a file is highlighted within a folder, it is the file that is selected by the emulator.
- Make sure the MPPS In Progress, MPPS Discontinued and MPPS Complete Tabs are set correctly with the right MPPS file selected.
MPPS Completed
MPPS DISCONTINUED