DICOM Scripting

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Wayne Keranen
Manager, Global Innovation Team
Varian Medical Systems, Inc.

Introduction

Varian's DICOM connectivity solutions since version 8.9 provide access to most of the DICOM-RT information that is stored in the Aria database. This is not well known, however, given that the connectivity is explained in the code of **DICOM Conformance Statements**.

The purpose of this document is to help researchers extract standard DICOM radiotherapy data programmatically from the Varian system. This article demonstrates how one can use the Eclipse Scripting API (ESAPI) together with the open-source package DCMTK to script Varian's DB Service to extract an RT Plan, its associated RT Structure Set and CT Image Series, and the calculated dose for the RT Plan.
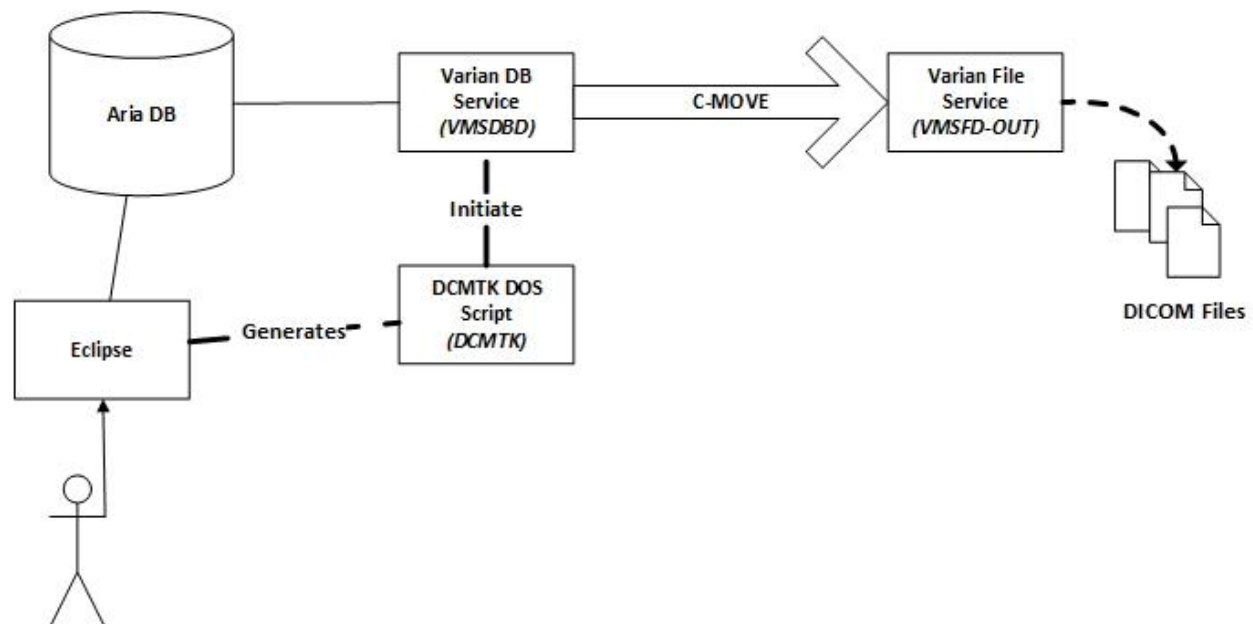
Figure 1 : Configured DICOM System Diagram

The system set up to demonstrate Varian's DICOM connectivity is shown below in Figure 1. The Varian DB Service is configured so it can be remotely controlled by the DCMTK package to send DICOM objects via C-MOVE to the Varian File Service. The Varian File Service then dumps those objects as DICOM files to a configured Windows location. This demonstration would not have required the VMS File Daemon, but including it has the added bonus that it demonstrates how one could remotely control the Varian DB Service to send DICOM objects to any DICOM system; be it an RT PACS, or other software that supports DICOM networking operations.

Configure the System

Install the Varian DB Service

Ask your local Varian service rep to install the Varian DB Service (Was called Varian DICOM DB Daemon pre-15.5) and the VMS File Service (Was called "VMS File Daemon" pre-15.5) for you on a server you have access to, or the local workstation you are working on. The Varian DB Service is normally set up on a server, but doesn't have to be. The computer it runs on should be a Varian client computer that is connected to the Aria database. Once this has been installed, you should see the workstation menu show below available on the computer it was installed on.   When "DICOM Services Configuration is clicked, the dialog in Figure 2 is shown.
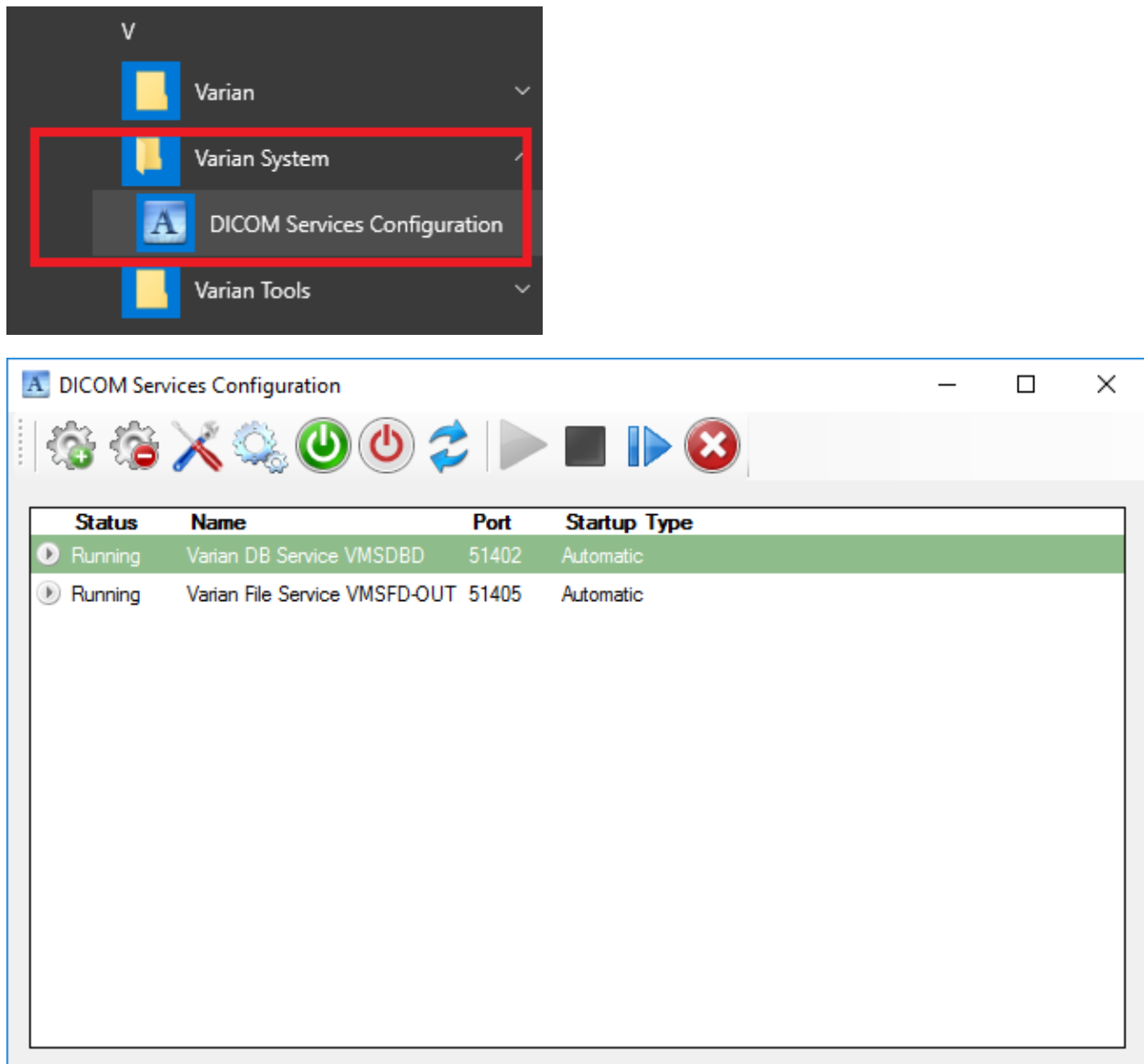

Figure 2: Varian DICOM Assets Installed

Install DCMTK

Download and install DCMTK on the workstation where you do your development / Eclipse Scripting. The install for Windows 10 seems to consist of unpacking a zip file to a directory. For this article DCMTK was unpacked to **C:\variandeveloper\tools\dcmtk-3.6.3-win64-dynamic**.

Configure the Varian DB Service

The Varian DB Service must know of and trust all of the players involved in the DICOM transaction. Here we configure the AE Titles (Application Entity Titles: DICOM jargon) used in the system. These AE Titles are completely arbitrary and could be any string, but they must match in the correct ways in all of the configuration here or the system will not work. For this article, AE Titles are configured as shown in Table 1.

Software	**AE Title**
Varian DB Service	VMSDBD
DCMTK	DCMTK
VMS File Service	VMSFD-OUT

Table 1: Configured DICOM AE Titles

Note: This configuration was done with version 15.5 of the DICOM Services Configuration tool. When configuring earlier versions, the dialogs may not look the same.

To start, double click the "Varian DB Service" in the DICOM Services Configuration tool, or click the gear icon with a green plus on it ( ) if there is no Varian DB Service in the list.

Figure 3: DICOM DB Service Configuration Step 1

Trust VMS File Service Daemon

Click the "Add New" button near the Trusted Application Entities section.

Fill in the AE Title and Port as shown in Figure 4, then click OK. The IP address is specific to your install situation. Put the IP address where you have the Varian File Service installed.
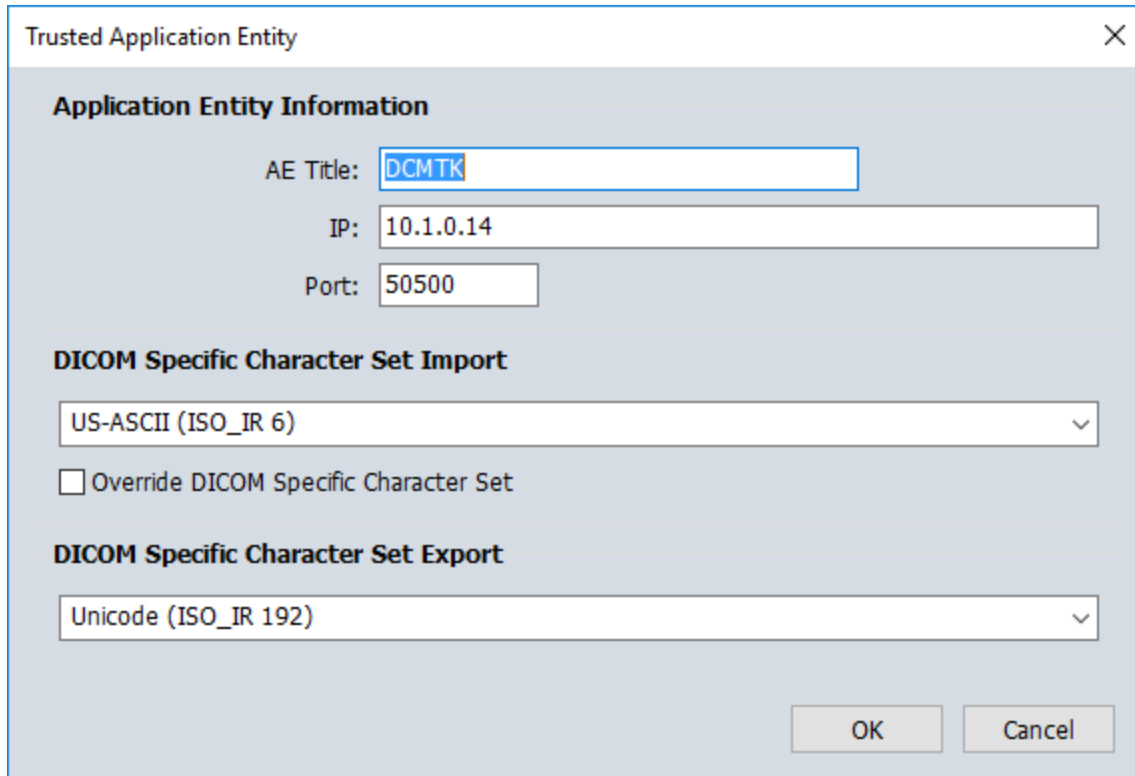
Figure 4: DICOM DB Service Configuration Step 2

Trust DCMTK

Click the "Add New" button near the Trusted Application Entities section.

Fill in the AE Title and Port as shown in Figure 5, then click OK. The IP address is specific to your install situation. Put the IP address where you are running DCMTK scripting from. In this case, the Eclipse Client is installed on 10.1.0.14, that is also where DCMTK is installed.
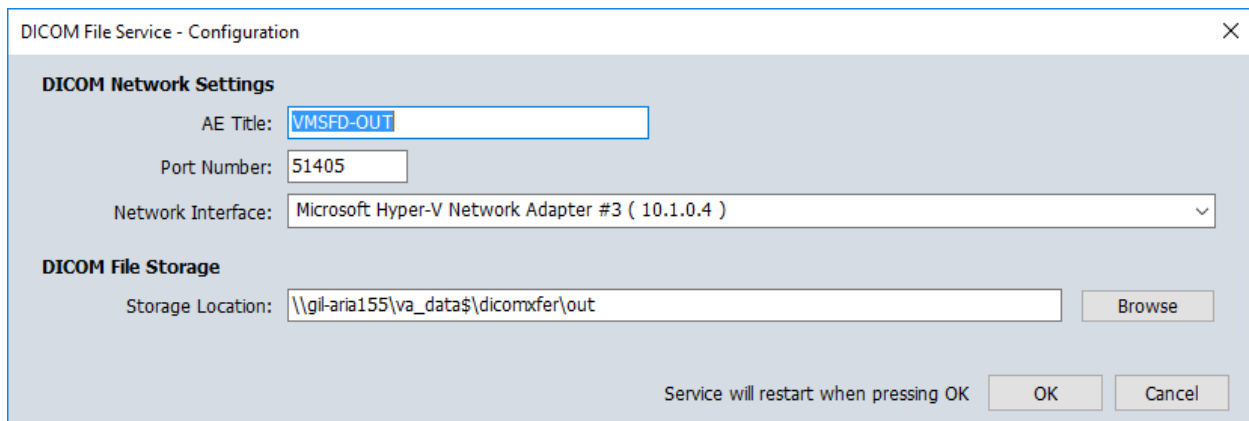
Figure 4: DICOM DB Service Configuration Step 3

Configure the Varian File Service

The Varian File Service must be configured with the trusted AE title and port, and with the location to write DICOM files to.   To start, double click the "Varian File Service" in the DICOM

Services Configuration tool, or click the gear icon with a green plus on it ( ) if there is no Varian File Service in the list. Configure as shown, with Storage Location that is specific to your situation. The Storage Location path must be accessible by the VMS File Service.

Figure 5: DICOM File Service Configuration Step 1

Test the Configuration with DCMTK

Use the windows command prompt together with DCMTK so we can be sure the DICOM DB Service and the DICOM File Service are configured properly. Get the UID of an image series from Eclipse, and use that for a command line extraction.

Dump an image series

Run the Eclipse External Beam application. Load a patient with at least 3D image data.   Then click the Open Patient button to open the "Object Explorer". Click the DICOM View folder, choose a study and drill down to a Series for a 3D Image. Right menu click "Properties", then click the Technical Tab. Copy the Series UID.
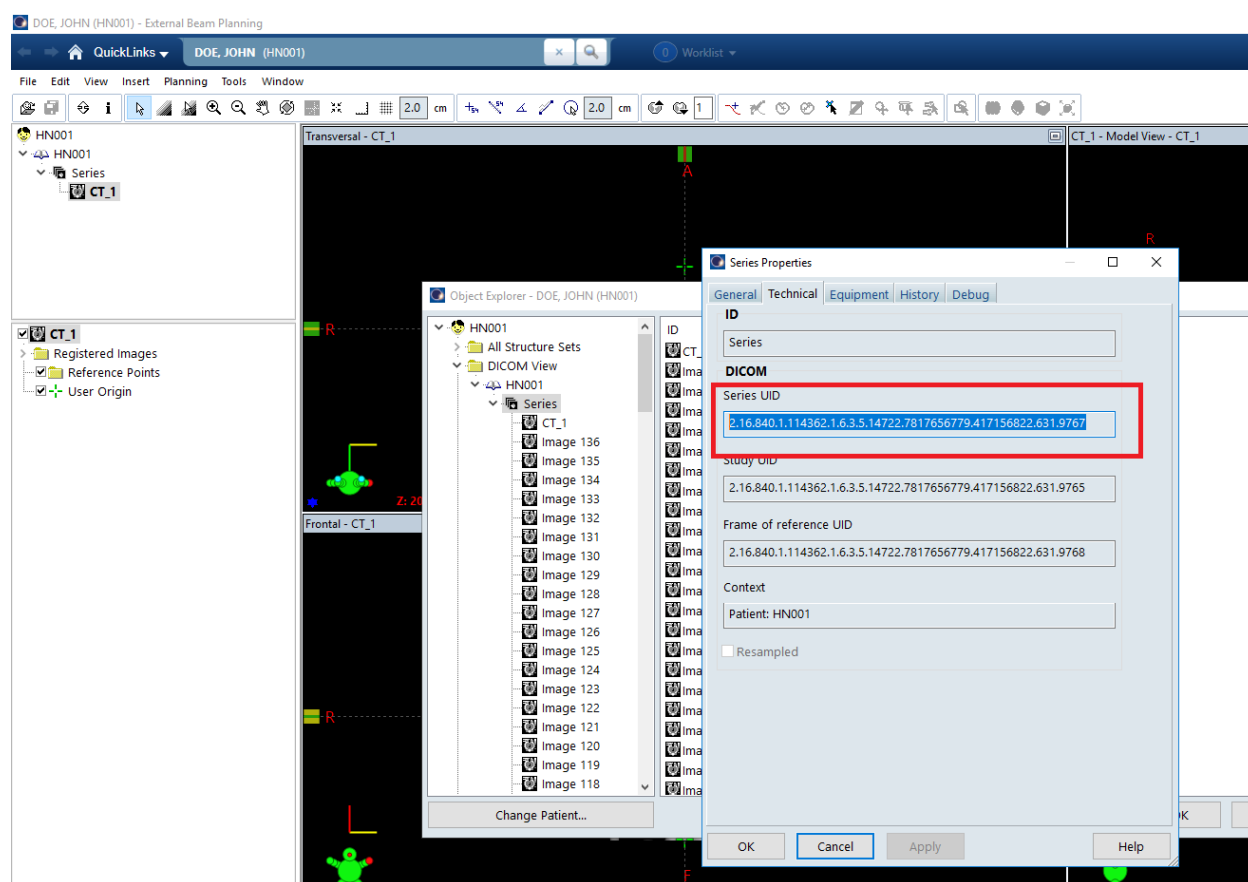
Open a command prompt window, first set the path so the DCMTK binaries can be used, and then type a similar command and paste in the UID where appropriate (after the -k "0020,000E=)
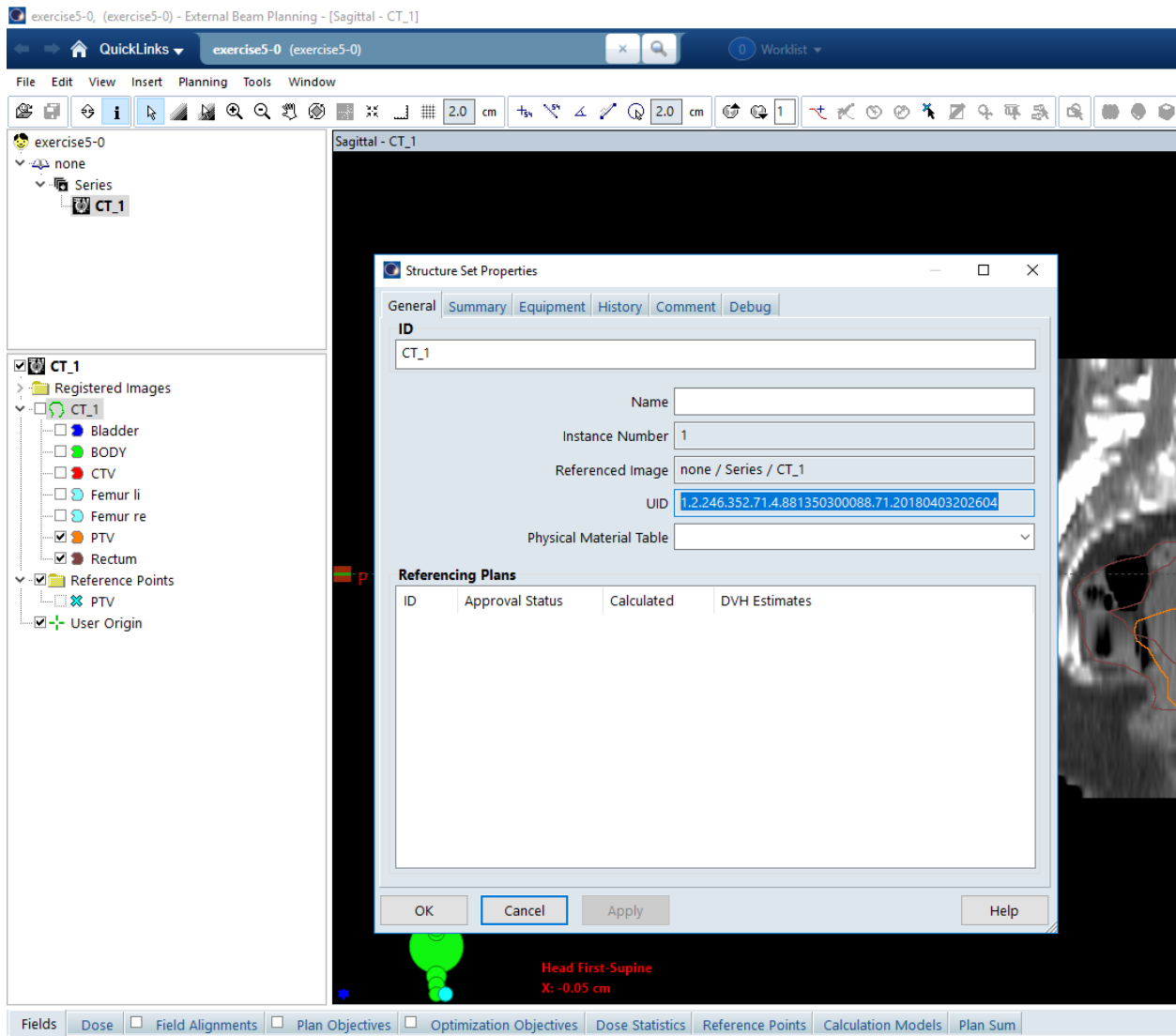

Example command:

movescu -v -aet DCMTK -aec VMSDBD -aem VMSFD-OUT -S -k "0008,0052=SERIES" -k "0020,000E=2.16.840.1.114362.1.6.3.5.14722.7817656779.417156822.631.9767" 10.1.0.4 51402

(https://support.dcmtk.org/docs-354/movescu.html)

After successfully running this command, the entire image series is dumped out to the VMS File Service Storage Location configured. In this case, the image series is dumped to "\\gil-aria155\va_data$\dicomxfer\out\", add the patient ID1 - "\\gil-aria155\va_data$\dicomxfer\out\HN001".

Dump an RTStructureSet

With a Patient and Structure Set loaded in Eclipse, right click on the structure set id in the left most context tree. Right menu click "Properties". Copy the UID.

Corresponding Example command:

movescu -v -aet DCMTK -aec VMSDBD -aem VMSFD-OUT -S -k "0008,0052=IMAGE" -k "0008,0018=1.2.246.352.71.4.881350300088.71.20180403202604" 10.1.0.4 51402

Dump an RTPlan

With a Patient and Plan loaded in Eclipse, right click on the Plan id in the left most context tree. Right menu click "Properties". Copy the UID.
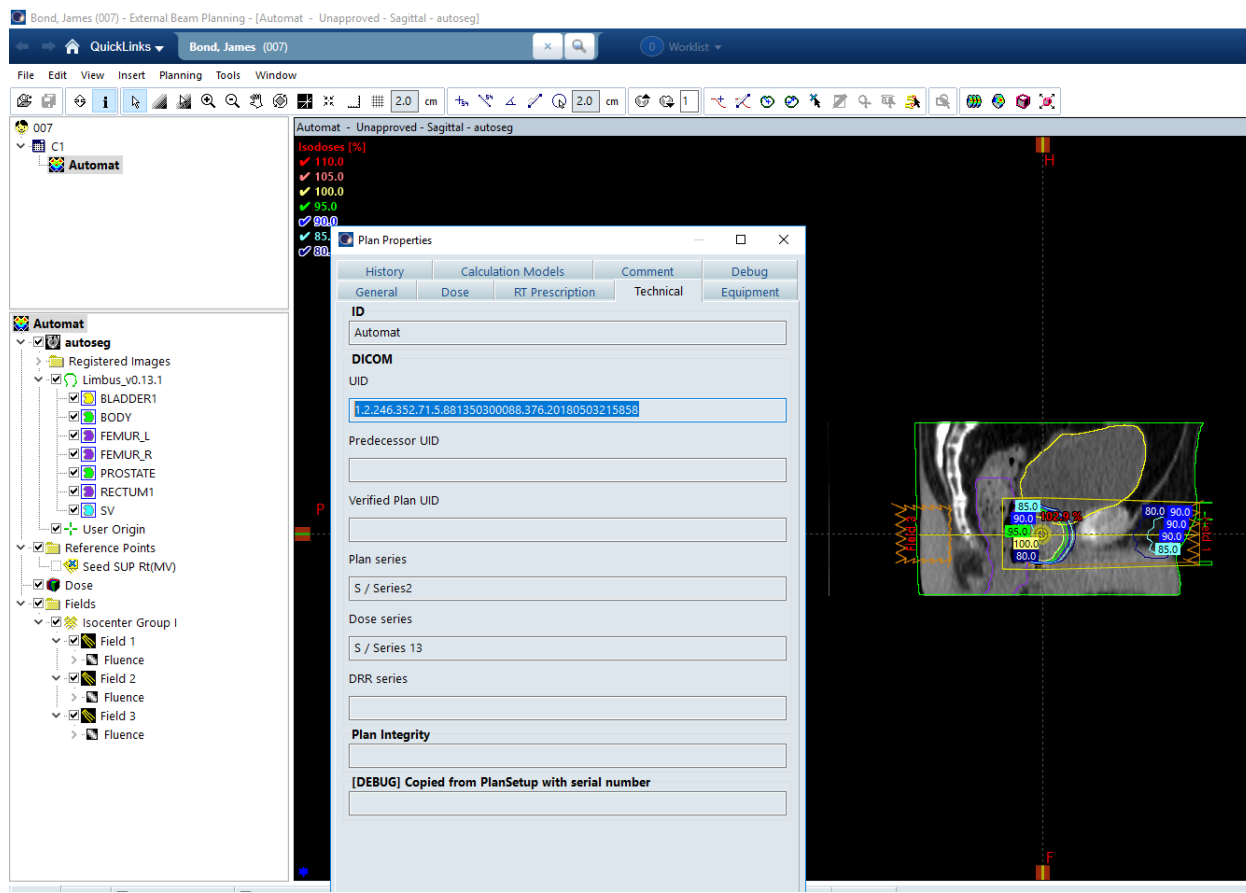
Corresponding Example command:

movescu -v -aet DCMTK -aec VMSDBD -aem VMSFD-OUT -S -k "0008,0052=IMAGE" -k "0008,0018=1.2.246.352.71.5.881350300088.376.20180503215858" 10.1.0.4 51402

There are many other ways to query the Varian DB Service, and ways to extract data. The Varian DICOM Conformance statement can be studied to learn all that can be done.

Injecting data

The DCMTK command "storescu" can be used to inject or upload data to the Varian DB Service. Injection has more stringent requirements; for example, when injecting structure set data, the 3D image to which the structure set is connected needs to exist in the Aria DB already. When injecting RTPlans, the StructureSet for the plan needs to exist, and the Machine (External Beam Linear Accelerator) defined in the plan must exist in RT Administration and have the exact ID as defined in the plan.

Example command that injects a single structure set into Aria from file "ss.dcm":

storescu -v 10.1.0.4 51402 -aet DCMTK -aec VMSDBD C:\Users\wkeranen\Downloads\AutoSeg\ss.dcm

Example command that injects all DICOM files from a directory:

storescu -v 10.1.0.4 51402 -aet DCMTK -aec VMSDBD +sd C:\Users\wkeranen\Downloads\AutoSeg

When injecting all files from a directory, the tools don't understand ordering required by Aria, so this method usually only works when sending in an Image series into the Aria DB.

Ordering required when injecting data:

➔ 3D Image
➔ RT Structure Set
➔ RT Plan
➔ RT Dose

Integrating DICOM Scripting with Eclipse Scripting

DICOM Query / Retrieve network operations could be used to find the DICOM UIDs necessary to move the package of Plan, Structure Set, CT Image, and Dose files. Building the right query can be quite challenging for the DICOM novice however, so we simplify that step here by using the Eclipse Scripting API to get the DICOM UIDs needed.

Download the project "GetDicomCollection" from the github site, tweak the parameters in file GetDicomCollection.cs to match your configured environment.

Project:

https://github.com/VarianAPIs/samples/tree/master/Eclipse%20Scripting%20API/projects/GetDicomCollection

Source File:

https://github.com/VarianAPIs/samples/blob/master/Eclipse%20Scripting%20API/plugins/GetDicomCollection.cs

```
    public const string DCMTK_BIN_PATH= @"C:\variandeveloper\tools\dcmtk-3.6.3-win64-
dynamic\bin"; // path to DCMTK binaries

    public const string AET = @"DCMTK";        // local AE title

    public const string AEC = @"VMSDBD1";      // AE title of VMS DB Daemon

    public const string AEM = @"VMSFD";        // AE title of VMS File Daemon

    public const string IP_PORT = @" 10.1.0.4 51402";// IP address of server hosting
the DB Daemon, port daemon is listening to

    public const string CMD_FILE_FMT = @"{0}\move-{1}({2})-{3}.cmd";
```

When done editing; save, compile, etc.

Run Eclipse, load a case that has a plan, structure set, CT data, and dose. Choose menu item Tools/Scripts, then choose the GetDicomCollection.cs script and run it.

Other DICOM Programming Tools & Packages

The commands demonstrated here with DCMTK can be programmed with other DICOM packages that support DICOM networking operations. Some packages known to work are:

- Java – PixelMed
- C# - FO-DICOM
- C# - EvilDICOM
- Python - pyDICOM

References

1. DCMTK – https://support.dcmtk.org/docs/index.html
2. PixelMed - http://www.pixelmed.com/
3. FO-DICOM - https://fo-dicom.github.io/
4. EvilDICOM - http://rexcardan.github.io/Evil-DICOM/index.html
5. pyDICOM - https://github.com/pydicom