Starviewer
Medical Imaging Software

Starviewer 2.0

Technical manual for administrators

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1. Installation

Below are the steps to install Starviewer on Windows and Ubuntu systems.

1.1. Installer verification

It is important that before installing the program, you verify the integrity of the installer by checking that its hash matches the one provided to you along with the download link. If it does not match, delete the file and download it again.

You can calculate the hash as follows:

Windows (PowerShell)

```
Get-FileHash starviewer~2.0.0-CE~amd64-winnt.msi
```

Linux

```
sha256sum starviewer~2.0.0-CE~amd64-ubuntu.deb
```

1.2. Running the installer

For Windows, run the installer file (MSI) (e.g. starviewer~2.0.0-CE~amd64-winnt.msi) and follow the provided steps.

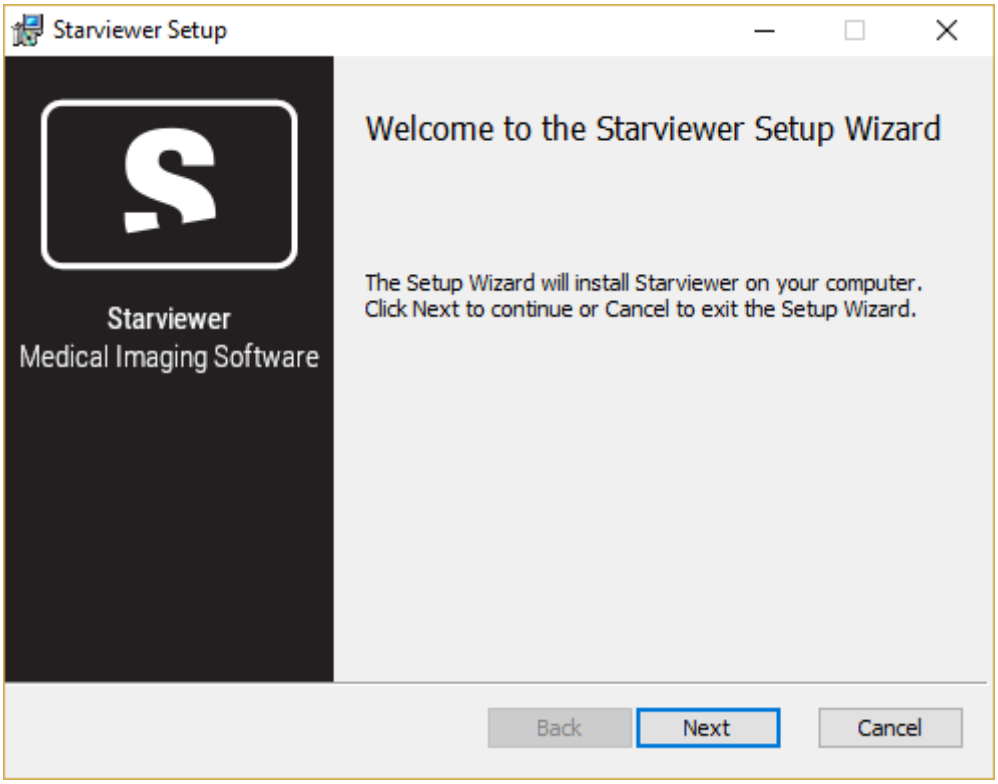

Figure 1: Installer's initial screen.

For Ubuntu, install the DEB package using apt:

```
sudo apt install starviewer~2.0.0-CE~amd64-ubuntu.deb
```

> Note: The file names above are examples. The version number will change each time, and the file naming structure may vary over time.

> Always check the result of the file's hash function (SHA-256) to verify it matches the one you have been provided.

Once the steps indicated by the installation wizard are completed, you can proceed to configure the basic settings of the application.

1.3. Definition of configuration settings permissions

The administrator can manage which configuration parameters the user can modify and which ones they cannot. To do this, it is necessary to create an INI file in the application's install folder, where the system parameters will be defined. Details regarding the name and content of this file can be found in section 3.1.

It is important to complete this step before proceeding further, determining which parameters should be user-specific and which should be system-specific.

1.4. PACS connection parameters configuration

In order for Starviewer to connect to a PACS server, the following parameters need to be configured:

1. Define the list of PACS that users will be able to access. This includes parameters defining each of the PACS and the default list of PACS the user will query.

For DIMSE or hybrid (WADO-URI + DIMSE) PACS setups, more configurations are necessary:

2. Assign the local port through which communication operations with the PACS will be conducted.
3. Assign the local AE Title that identifies the client.

> In order to retrieve studies from the configured PACS, each client must be registered in each of the PACS with their corresponding IP address. In the case of DIMSE or hybrid PACS setups, the AE Title and port are also required.
>
> It is highly recommended to ensure that the chosen local port is not blocked by any firewall or in use by any other application. By default, the port assigned by Starviewer is 4006.

> By default, Starviewer configures the hostname as AE Title. It is important to note that the PACS may consider the AE title case sensitive.

1.4.1. Configuration through the graphical interface

This option is only advisable when making a single installation (personal scope).

Access the configuration window through the menu `Tools > Configuration...`. In the `PACS` section, you can add the PACS you want to configure.

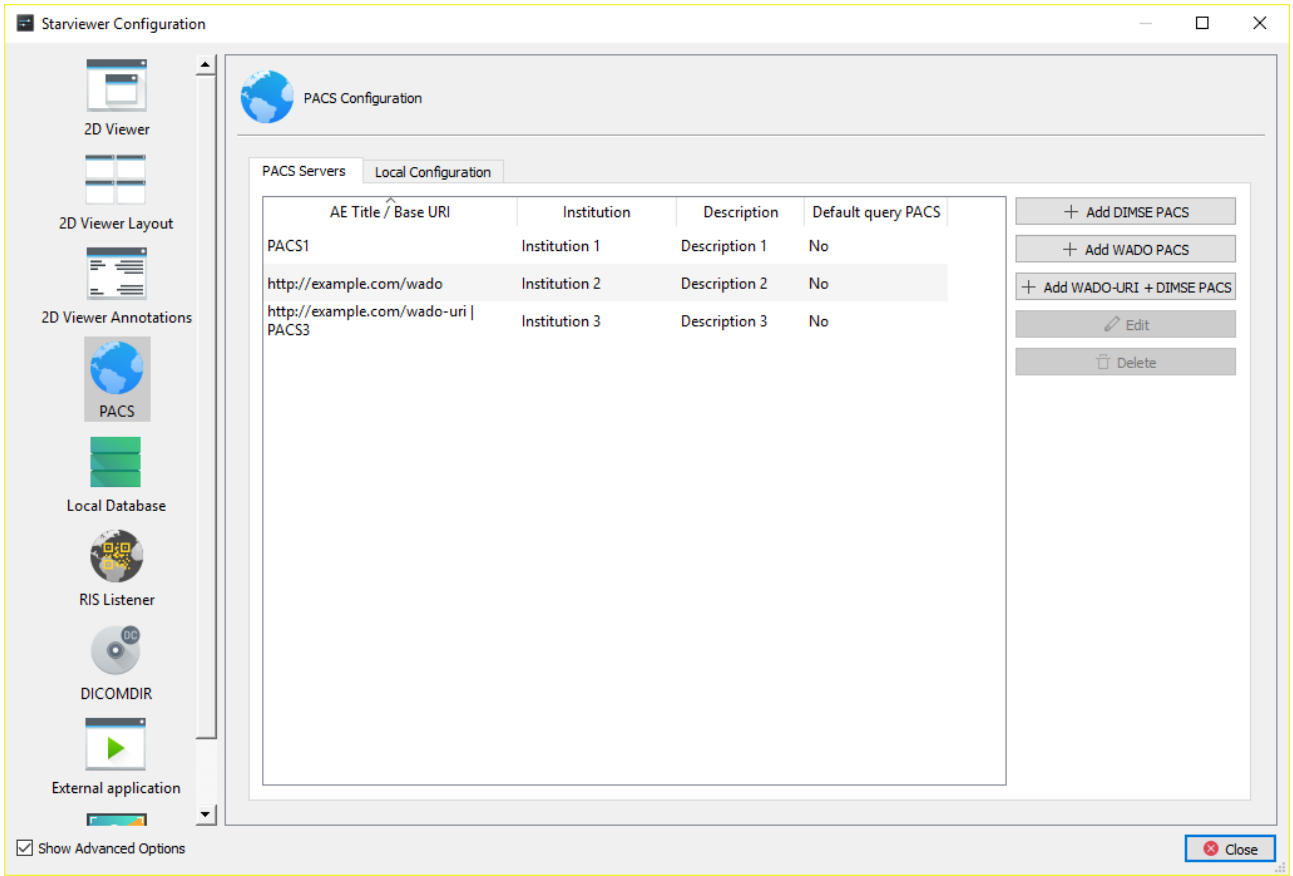

Figure 2: Configuration screen for the list of PACS.

In the `Local Configuration` tab, you can edit the AE Title and the local port.

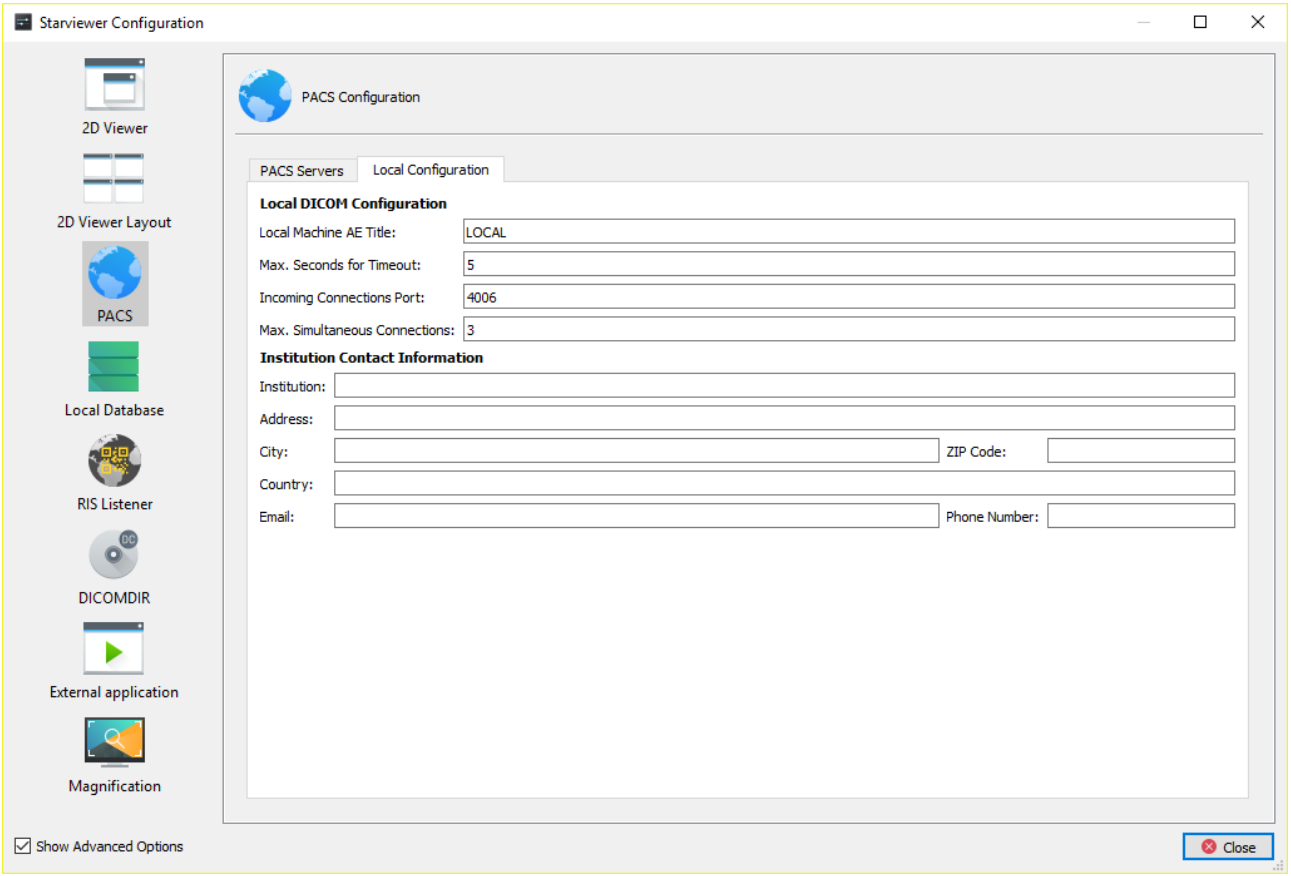

Figure 3: Configuration screen for local communication parameters.

1.4.2. Configuration via files

This option is suitable when configuring 2 or more workstations (common in a hospital environment).

It is recommended to define at least the PACS list, the AE Title, and the local port as system parameters (see section 1.3).

In this case, the configuration is done directly in one or several text files, allowing easy replication across multiple workstations. In the case of Windows, a Windows Registry file (REG) is edited, and changes can be applied on each machine by double-clicking on the file or using more automated systems like command-line programs or group policies. For Linux (Ubuntu), the configuration is done with INI files. You will find more details about both systems in section 2.

Below, it is explained how the various configuration parameters related to PACS are defined.

1.4.2.1. List of available PACS

First, you need to declare the names of the servers that will be available:

Windows

```
[HKEY_LOCAL_MACHINE\SOFTWARE\GILab\Starviewer\PacsList]
"size"=dword:0000000x
```

Where x is the number of servers in hexadecimal.

Next, for each PACS, you need to define a block as follows:

Windows

```
[HKEY_LOCAL_MACHINE\SOFTWARE\GILab\Starviewer\PacsList\n]
"ID"="0"
"Type"="WADO-URI+DIMSE"
"AETitle"="PACS1"
"PacsHostname"="10.0.0.1"
"QueryRetrieveServiceEnabled"="true"
"PacsPort"="11112"
"StoreServiceEnabled"="true"
"StoreServicePort"="11112"
"BaseUri"=hex:40,00,56,00,61,00,72,00,69,00,61,00,6e,00,74,00,28,00,00,00,00,\
  00,00,00,11,00,00,00,00,00,00,00,1b,00,68,00,74,00,74,00,70,00,3a,00,2f,00,\
  2f,00,65,00,78,00,61,00,6d,00,70,00,6c,00,65,00,2e,00,63,00,6f,00,6d,00,2f,\
  00,77,00,61,00,64,00,6f,00,2d,00,75,00,72,00,69,00,29,00
"Institution"="Institution 1"
"Location"="Location 1"
"Description"="Description 1"
```

Where n is the position of the PACS in the list (in decimal, in ascending order starting from 1).

The equivalent configuration for Linux would be as follows:

Linux

```
[PacsList]
n\ID=0
n\Type=WADO-URI+DIMSE
n\AETitle=PACS1
n\PacsHostname=10.0.0.1
n\QueryRetrieveServiceEnabled=true
n\PacsPort=11112
n\StoreServiceEnabled=true
n\StoreServicePort=11112
n\BaseUri=@Variant(\0\0\0\x11\0\0\0\x1bhttp://example.com/wado-uri)
n\Institution=Institution 1
n\Location=Location 1
n\Description=Description 1
size=d
```

Where n is the position of the PACS in the list (in decimal, in ascending order starting from 1), and d is the number of servers in decimal.

Annex B explains all the possible parameters of a PACS server.

1.4.2.2. Default PACS to query

The default PACS are stored in the key defaultPACSListToQuery2 in a specific format explained after the following examples:

Windows

```
[HKEY_LOCAL_MACHINE\Software\GILab\Starviewer\PACS]
"defaultPACSListToQuery2"="PACS1.2.3.4:1234\\\\http://example.com/wado/\\\\
http://example.com/wado-uri⇶PACS110.0.0.1:11112\\\\"
```

Linux

```
[PACS]
defaultPACSListToQuery2=PACS1.2.3.4:1234\\\\http://example.com/wado/\\\\
http://example.com/wado-uri\xd808\xde56PACS110.0.0.1:11112\\\\
```

To identify each PACS, it is done as follows:

- DIMSE PACS: <AETitle><IP>:<QRPort>
- WADO PACS: <BaseUri>
- Hybrid PACS: <BaseUri>⇶<AETitle><IP>:<QRPort>

Where:

- <AETitle> is the PACS's AE Title
- <IP> is the PACS's IP address or hostname
- <QRPort> is the Query/Retrieve port of the PACS
- <BaseUri> is the PACS's base URI
- ⇶ (in Linux represented as \xd808\xde56) is a special character to separate the base URI from other information in hybrid PACS

Each PACS identifier is separated by \\\\ and the string always ends end with \\\\.

> If "defaultPACSListToQuery2" is defined as a system parameter, all users will have the same values and will not be able to modify them. However, if "defaultPACSListToQuery2" is defined as a user parameter, all users will have the same default PACS to query initially, but they can modify the selection later. In other words, we can provide a default value, but they can modify it.

1.4.2.3. Local communication port

This parameter indicates the port through which Starviewer communicates with the PACS servers for Query/Retrieve operations. If this key is not specified, the default port configured is 4006.

Windows

```
[HKEY_LOCAL_MACHINE\SOFTWARE\GILab\Starviewer\PACS\pacsparam]
"localPort"="4007"
```

Linux

```
[PACS]
pacsparam\localPort=4007
```

1.4.2.4. Local AE Title

If the local AE Title is different from the hostname, it will be necessary to assign the corresponding AE Title to each computer.

If the AE Title follows a defined pattern, it's possible to parametrize the AE Title. Refer to the section 4 for an explanation on how to do it.

If the AE Title does not follow any pattern that can be defined with the existing variables, a different file will have to be created for each machine to set a different AE Title for each.

Windows

```
[HKEY_LOCAL_MACHINE\SOFTWARE\GILab\Starviewer\PACS\pacsparam]
"AETitle"="PCHOSPITAL198"
```

Linux

```
[PACS]
pacsparam\AETitle=PCHOSPITAL198
```

1.5. Basic operation check

Once Starviewer is configured, we recommend verifying its proper operation:

1. Run the diagnostic tests (`Tools > Run diagnosis tests`) and ensure there are no errors; ideally, there should be no warnings either.
2. Download a study from a PACS, open it, and verify that it is displayed.
3. Open the user manuals from the `Help` menu and ensure they open correctly.

If all checks pass, it indicates that the installation is successful and the system is ready to run Starviewer.

2. Configuration locations

Configuration options can be stored in different locations depending on the platform and the access level of each setting.

2.1. Windows

In Windows, the configuration is stored in the Windows Registry. The root keys are as follows:

- User settings: HKEY_CURRENT_USER\Software\GILab\Starviewer
- System settings: HKEY_LOCAL_MACHINE\Software\GILab\Starviewer

The configuration can be edited directly with regedit or using REG files.

2.2. Linux

In Linux, the configuration is stored in configuration files. The locations of these files are as follows:

- User settings: $HOME/.config/GILab/Starviewer.conf
- System settings: <dir>/GILab/Starviewer.conf, where <dir> is any directory indicated in the $XDG_CONFIG_DIRS environment variable; if the variable is empty, /etc/xdg is taken by default.

These files are plain text and follow the INI format. They can be edited with any text editor.

3. Settings access levels

By default, Starviewer does not impose any restrictions on any application configuration parameter. This means that any parameter is modifiable by any user. In some environments, it might be desirable that the user cannot modify certain parameters; therefore, a mechanism is provided where the administrator can decide which parameters can only be modified by administrators. This mechanism involves defining an INI file declaring which parameters are system parameters.

Declaring a parameter as a system parameter implies:

- The value of that parameter will be the same for all users on the machine.
- Only the system administrator can modify the value of that parameter.

Declaring a parameter as a user parameter (those not declared as administrator parameters) implies:

- The value of that parameter can be different among users.
- Any user can modify the value of that parameter, affecting only that user.

3.1. INI file to define access levels

The application searches for the access level definition file in the same folder as the executable, and the name must be `settingsAccessLevel.ini`. If the default installation location is maintained, the full path is as follows:

- Windows: `C:\Program Files\Starviewer\settingsAccessLevel.ini`
- Linux: `/opt/starviewer/settingsAccessLevel.ini`

Each configuration parameter has its own key. These keys are structured within groups and subgroups. This file should define the access level for each key. The accepted access levels are `user` and `system`. Since by default all parameters are of type `user`, only those that need to be of type `system` must be defined.

Below is an example of an access level definition file.

3.1.1. Example

```
settingsAccessLevelVersion=1.0
PacsList=system

[PACS/cache]
deleteOldStudiesHasNotViewedInDays=system
deleteOldStudiesIfNotEnoughSpaceAvailable=system

[PACS/pacsparam]
AETitle=system
localPort=system
timeout=system
MaxConnects=system
```

```
[PACS/risRequests]
listen=system
listenPort=system
viewAutomaticallyAStudyRetrievedFromRisRequest=system
```

The format is that of a typical INI file, meaning `key=value` definitions that can be grouped within groups and subgroups.

The file must contain the key `settingsAccessLevelVersion`, which defines the version of the file format used. It must always be `1.0`.

The rest of the keys have the name of a configuration key and the value `system` or `user`.

Groups and subgroups can be defined within section names (with `/`) or within the key name (with `\`). Keys outside any section are considered within the `General` section. With these rules, the example below is equivalent to the one above.

```
[General]
settingsAccessLevelVersion=1.0
PacsList=system

[PACS]
cache\deleteOldStudiesHasNotViewedInDays=system
cache\deleteOldStudiesIfNotEnoughSpaceAvailable=system
pacsparam\AETitle=system
pacsparam\localPort=system
pacsparam\timeout=system
pacsparam\MaxConnects=system
risRequests\listen=system
risRequests\listenPort=system
risRequests\viewAutomaticallyAStudyRetrievedFromRisRequest=system
```

3.2. Settings recommended for system access

3.2.1. Local database settings

These settings define the operation and management of the local database and the DICOM image cache of the application.

Group [PACS/cache]

Key	Description
sdatabasePath	Full path of the local database file
imagePath	Full path of the folder where downloaded studies are stored locally
deleteOldStudiesHasNotViewedInDays	Allows enabling or disabling automatic deletion of locally downloaded studies that have not been viewed for days

Key	Description
deleteOldStudiesIfNotEnoughSpaceAvailable	Allows enabling or disabling automatic deletion of locally downloaded studies when there is insufficient disk space
MaximumDaysNotViewedStudy	Maximum number of days a study will be retained before deletion if automatic deletion of old studies is enabled
minimumSpaceRequiredToRetrieveInGbytes	When free disk space falls below this amount of gibibytes, older studies will be deleted to make room if the corresponding option is enabled
GbytesOfOldStudiesToDeleteIfNotEnough-SapaceAvailable	Amount of gibibytes to be deleted from local studies when the deletion of studies due to lack of space is enabled

3.2.2. Settings for communication with PACS

These settings define the communication with DIMSE-type PACS servers.

Group [PACS/pacsparam]

Key	Description
localPort	Local port where connections from the PACS are accepted while studies are being downloaded with DIMSE
AETitle	AE Title of Starviewer for DIMSE communications
timeout	Maximum wait time in seconds to receive a response from a DIMSE PACS
MaxConnects	Maximum number of simultaneous connections for search or send operations with DIMSE PACS (for downloading, it is set to a maximum of 1)

3.2.3. PACS list

Key	Description
PacsList	Under this key, the list of PACS is stored

3.2.4. Settings for communication with RIS/HIS

These settings define how the application communicates with RIS/HIS applications.

Group [PACS/risRequests]

Key	Description
listen	Enables or disables the RIS/HIS listening port
listenPort	RIS/HIS listening port

Key	Description
viewAutomaticallyAStudyRetrievedFromRisRequest	Controls whether or not a study requested via RIS/HIS is viewed once downloaded

3.2.5. DICOMDIR creation settings

These settings define some aspects of DICOMDIR creation from Starviewer.

Group [DICOMDIR]

Key	Description
DICOMDIRBurningApplication	External program to burn a DICOMDIR on CD or DVD
DICOMDIRBurningApplicationHasDifferentCDDVDParameters	Controls whether the burning program has different arguments for CD and DVD
DICOMDIRBurningApplicationParameters	Execution arguments for the burning program (applied only when they are the same for CD and DVD)
DICOMDIRBurningApplicationCDParameters	Execution arguments for the burning program specific to CD (applied only when they are different and a CD is burned)
DICOMDIRBurningApplicationDVDParameters	Execution arguments for the burning program specific to DVD (applied only when they are different and a DVD is burned)
ConvertDICOMDIRImagesToLittleEndian	Activates or deactivates the conversion of images to Explicit Little Endian (more standard and potentially fewer compatibility issues) instead of maintaining the original format

4. Definition of settings with expressions

Some setttings support definition through variables and masks that allow defining the value of the setting with an expression. This provides flexibility when defining values, making them depend on machine or environment properties.

For example, if you want to define that the local AE Title is composed of the machine name and a suffix "SV", you can define its value like this: %HOSTNAME%SV.

4.1. Recognised variables

To use a variable within an expression, you need to write the variable name between "%". Example: %VARIABLE_NAME%. You can concatenate as many variables and constant values as you want.

The following table lists the recognised variables.

Variable	Description
HOSTNAME	Host name
IP	IPv4 address of the machine in the format xxx.xxx.xxx.xxx
IP.X	Component "X" of the IPv4 address, where X is between 1 and 4 (example: IP.4 is the fourth component of the IP)
USERNAME	Username of the current session
HOMEPATH	Home directory of the current session

4.2. Masks

Each variable can be applied a mask to obtain more elaborate and complex combinations. The syntax is %VARIABLE_NAME%[n:c], where:

- %VARIABLE_NAME%: variable to which the mask is applied.
- n: the value of the variable will be truncated (and optionally extended) to this number of characters; it must be a natural number > 0.
- c: padding character with which the value of the variable will be extended; it can be any character other than whitespace (spaces, line breaks, tabs, etc.) and is an optional parameter (it can be left empty).

This mask will truncate the value of the specified variable to n characters, taking the first n characters. If the value is shorter than n characters and a padding character c has been specified, the value will be extended by adding as many c characters to the left as needed to achieve the length n.

4.2.1. Examples

To obtain the last 5 digits of the IP address and fill in the spaces with the character "x", you can write:

```
%IP.3%[2:x]%IP.4%[3:x]
```

With the IP address 10.80.9.2, the result would be “x9xx2”: third component of the IP (“9”) taking a maximum of 2 characters and filling with “x” (“x9”), followed by the fourth component of the IP (“2”) taking a maximum of 3 characters and filling with “x” (“xx2”).

In a small variation, to obtain the last 4 digits without padding, you can write:

```
%IP.3%[1:]%IP.4%[3:]
```

In this case, for the same IP address, the result would be “92”: third component of the IP (“9”) taking a maximum of 1 character (“9”), followed by the fourth component of the IP (“2”) taking a maximum of 3 characters (“2”).

4.3. Settings compatible with expressions

Expressions with variables and masks are only applicable to the following settings:

- PACS/cache/sdatabasePath
- PACS/cache/imagePath
- PACS/pacsparam/AETitle

5. Integration with RIS or SAP

Starviewer offers various ways to open studies from an RIS or SAP.

5.1. Command line arguments of the Starviewer executable

This is the main and recommended method, also the most powerful one. Starviewer can receive a study identifier as a command line argument and then loads it from the local database if available, or searches and downloads it from the default activated PACS otherwise.

There are 3 recognized command line options in Starviewer; other options result in an error; if more than one option is specified, only the highest-priority one is considered.

The recognized options, in descending order of priority, are:

- studyinstanceuid: allows specifying a study by its Study Instance UID (0020,000d).

  Example: `starviewer -studyinstanceuid 1.2.276.0.7230010.3.1849863617`

- accessionnumber: allows specifying a study by its Accession Number (0008,0050).

  Example: `starviewer -accessionnumber 37049998718078`

- url: allows specifying a study using a URL with one of the formats indicated in the next section.

  Example: `starviewer -url starviewer://accessionnumber/37049998718078`

All parameters can be indicated with one or two dashes interchangeably, e.g., `-url` or `--url`.

If the Starviewer executable is not in the `PATH`, the full path must be indicated, e.g., `"C:\Program Files\Starviewer\starviewer.exe" -accessionnumber …`.

5.2. URL

The second way to instruct Starviewer to open a study is by opening a URL. During installation, Starviewer is automatically configured to handle a custom URL format. This allows opening studies from a web interface RIS if configured to generate this type of link. The recognised formats are:

- starviewer://studyinstanceuid/1.2.276.0.7230010.3.1849863617
- starviewer://accessionnumber/37049998718078

When one of these links is opened, Starviewer is executed with the `--url` option indicated in the previous section, passing it the URL.

5.3. Auxiliary executable (SAP wrapper)

This method allows opening a study identified by its Accession Number by invoking an auxiliary executable installed along with Starviewer.

Example: `starviewer_sapwrapper 37049998718078`.

This program just invokes Starviewer with the `-accessionnumber` option mentioned above. It is recommended to use directly one of the options of the main executable.

5.4. XML through a network port

The last option for opening a study in Starviewer from the outside is sending an XML through a network port configured to listen to requests from the RIS. This method allows opening a study identified by its Accession Number.

The default listening port is 11110, but it can be changed in settings.

The XML must have the following format:

```
<?xml version="1.0" encoding="UTF-8"?>
<Msg Name="OpenStudies">
    <Param Name="AccessionNumber">37049998718078</Param>
</Msg>
```

6. Definition of external applications

Starviewer allows defining external applications where, upon user request, the currently viewed study is opened. These external applications can be configured directly through the Starviewer graphical interface or through the Windows registry or configuration file.

External applications are stored in a list and therefore follow a structure similar to that of the PACS list (1.4.2.1). In this case, the parameters for each application are:

- `name`: the name that the user will see.
- `type`: the type of application. It can be `cmd` (executes a local command) or `url` (opens a URL).
- `url`: the command to execute or URL to open. It accepts a set of variables explained in Starviewer and the user manual.

6.1. Examples

Windows

```
[HKEY_LOCAL_MACHINE\SOFTWARE\GILab\Starviewer\ExternalApplications]
"size"=dword:00000002

[HKEY_LOCAL_MACHINE\SOFTWARE\GILab\Starviewer\ExternalApplications\1]
"name"="App 1"
"type"="url"
"url"="http://www.starviewer.org"

[HKEY_LOCAL_MACHINE\SOFTWARE\GILab\Starviewer\ExternalApplications\1]
"name"="App 2"
"type"="cmd"
"url"="echo \"Starviewer Medical {%AccessionNumber%}\""
```

Linux

```
[ExternalApplications]
1\name=App 1
1\type=url
1\url=http://www.starviewer.org
2\name=App 2
2\type=cmd
2\url=echo \"Starviewer Medical {%AccessionNumber%}\"
size=2
```

7. Configuration of annotations for DICOM printers

Starviewer allows configuring DICOM printers. The user manual explains how to do the general configuration and how to send images to print.

If the printer supports printing annotations, Starviewer can be configured to print the film with study information. To activate annotations in the printer configuration, one must select Yes in the field Supports Annotation Box in the advanced printer configuration and then indicate the format of the annotations to be printed in the Annotation Display Format field.

The value of this field depends on the printer manufacturer and corresponds to the DICOM tag Annotation Display Format ID (2010, 0030). By consulting the DICOM Conformance Statement of the printer, one can obtain the value to be entered. If the manufacturer indicates various possibilities, choose one that allows printing up to 6 annotations.

Below, we provide links to DICOM Conformance Statements and give the field value for different printers:

- Agfa
  - https://medimg.agfa.com/main/miscellaneous/interoperability/dicom_connectivity/
  - For most Agfa printers, such as DryStar 5300 and 5500, the value of the Annotation Display Format field must be ANNOTATION.
- Carestream
  - https://www.carestream.com/en/us/services-and-support/regulatory-notices/dicom
  - For most Carestream printers, such as DryView 5850 and 6850, the value of the Annotation Display Format field must be 6.
- Fujifilm
  - https://healthcaresolutions-us.fujifilm.com/support-services/digital-radiography/dicom-conformance-statements
  - For most Fujifilm printers, the value of the Annotation Display Format field must be FORMAT1.
- Sony
  - Currently, they do not have DICOM Conformance Statements on their website.
  - For most Sony printers, the value of the Annotation Display Format field must be FORMAT6M, if it has not changed.

8. Configure and burn with a CD robot

To use a CD robot, it must be configured in the same way as configuring a PACS, i.e., by adding it to the list of available PACS with its corresponding port and AE Title. See section 1.4 where this configuration is explained.

Once the CD robot is configured, send the studies to be burned on the CD. This can be done by following the steps below, which are the same as sending a study to a PACS, also explained in the user manual:

1. Open the local database tab (Ctrl+L).
2. Select the study.
3. Right-click on it and choose the option Send to PACS or use the shortcut Ctrl+S.
4. In the window that appears, choose the configured robot as the PACS.
5. Finally, confirm the sending by pressing the Send button.

9. Uninstallation

Starviewer can be uninstalled following the usual procedure for any other program in the operating system:

- On Windows, you can go to `Windows menu` > `Starviewer` > `Uninstall Starviewer`, or navigate to the `Add or remove programs` section in the configuration or control panel, find Starviewer, and click `Uninstall`.
- On Ubuntu, you can simply type `apt remove starviewer` in a terminal as an administrator or with `sudo`.

All data (cache, logs, memory dumps and custom hanging protocols and transfer functions) are kept in the user's directory. The configuration is retained in the locations specified in section 2.

9.1. Data deletion

To delete all user data, delete the .starviewer directory in the user's home directory. Default locations are:

- Windows: C:\Users\<user>\.starviewer
- Ubuntu: /home/<user>/.starviewer

This can also be done safely while Starviewer is installed to erase all data, provided that Starviewer is not running.

9.2. Configuration deletion

To delete all user configuration related to Starviewer, there are different procedures depending on the platform:

- Windows: logged in as the user in question, delete the key HKEY_CURRENT_USER\Software\GILab\Starviewer from the Windows Registry; logged in as another user, you need to find the correct user under HKEY_USERS.
- Ubuntu: delete the file GILab/Starviewer.conf under the user's configuration directory (by default /home/<user>/.config).

This can also be done safely while Starviewer is installed to erase all configuration and return to default values, provided that Starviewer is not running.

10. Security considerations and recommendations

> It is the responsibility of the institution where Starviewer is used to ensure that user and patient data is stored securely.

10.1. Sensitive data

Starviewer, being a cloud-independent DICOM viewer, stores data on user workstations. Starviewer retains sensitive data as indicated in the table below. To facilitate reading, we will use Unix-style separators (/) to indicate the location in all cases (so it should be understood as \ on Windows) and the element <starviewer-prefix> to indicate the start. This prefix should be interpreted as follows depending on the platform:

- Windows: <starviewer-prefix> = %USERPROFILE%\.starviewer
- Linux: <starviewer-prefix> = $HOME/.starviewer

Data	Description	Location
DICOM files (patient data)	Starviewer can download DICOM studies from the PACS or import them from a DICOMDIR. A study is typically composed of multiple DICOM files organised into series. Starviewer caches these files and stores them as received.	Under <starviewer-prefix>/pacs/dicom/ by default. It can be changed in settings.
Database (patient data)	A database to control which files are in the cache and to have the most important metadata available without having to read the files.	<starviewer-prefix>/pacs/database/dicom.sdb by default. It can be changed in settings.
Log file (minimal patient and user data)	The log file contains UIDs of studies, series, and instances of the downloaded files. This, by itself, does not constitute personally identifiable information, but it could be used to obtain this information from another source (e.g., the PACS). It also contains the names of some directories used by Starviewer, including the user home directory, which typically corresponds to the username.	<starviewer-prefix>/log/starviewer.log.

Data	Description	Location
Memory minidumps (potential patient or user data)	Memory minidumps that are generated when Starviewer fails and crashes. Although they are not complete dumps and mainly contain the stack trace of each execution thread and information about loaded binaries and the environment, it cannot be ruled out that under certain circumstances there may be some patient or user data.	Under <starviewer-prefix>/dumps/.

Cache studies are deleted when Starviewer is started if they have not been opened for 7 days or more. They are also deleted if more space is needed. Both behaviours can be customised in the configuration.

10.2. Recommendations

Next we offer a list of security recommendations to keep this data and Starviewer itself safe from unauthorised access:

- Do not give administrator accounts to regular users. Users should use accounts with only the privileges required to do their work.
- Apply logic access control to workstations. Protect user accounts with strong passwords or other measures.
- Use two-factor authentication (2FA). This ensures that the password alone is not enough to log in.
- Use alternatives to passwords like passkeys or other alternatives. This way, users do not need to remember possibly complicated passwords.
- Provide security training to all users. Users must know that they must not store passwords in a plain text file or on a post-it attached to the monitor. They should be able to identify common phishing and social engineering schemes. They should learn to log out of their user session when finishing their work.
- Enable auto-locking of the user session after some period of inactivity.
- Promptly install security updates of all software.
- Regularly verify integrity of static files. Certain files in a computer are not expected to change frequently (e.g. executable and library files of installed software will not change if it is not updated). A database with the properties of these files (hash, size and modification date) can be constructed and used to periodically verify that they have not unexpectedly changed.

- Use full disk encryption.
- Configure a firewall to limit inbound and outbound connections.
- Have an up-to-date antivirus.
- Hire one or more security experts.
- Perform security audits.
- Apply physical access control to workstation and other IT rooms. Do not allow any random person to enter there.
- Carefully choose providers of services and goods. Investigate their past, their owners, possible conflicting interests and contracting policies.
- Prefer directly contracted personnel for all tasks. Subcontracted personnel may change without notice and you would have to trust unknown people.
- Offer good salaries and working conditions to all personnel. Bad salary or conditions could be an incentive to perform an attack.

All of these recommendations reduce the risk of unauthorised access to data or software, not only related to Starviewer but in general. More could be given but we think it is enough. Also, not all of them have to be applied either. Some of them are even contradicting with others. The idea is to offer a broad range of security recommendations.

The hospital or other institution using Starviewer should decide what measures are appropriate and what not. Use common sense. Take into account that increased security usually comes at the cost of decreased usability, practicality, comfort, etc. Every security measure introduces new risks or even new security issues: automatic screen lock will increase the time needed to resume work or could lock it in an inappropriate moment when there is urgency to use a software; an antivirus will decrease performance of the whole computer and may remove an important file due to a false positive; a firewall may block a needed connection preventing a user to work; users may forget passwords or lose passkeys; full disk encryption will mean full loss of all data on disk if a bit of the encryption key is flipped. The organisation must decide on a good balance between security and functionality, taking into account also laws, standards and costs.

As demonstrated in the Mission: Impossible films and similar works and in real life facts, perfect security does not exist. The only 100% sure way to prevent unauthorised access to data is that the data does not exist.

At the end of the day, security must be considered holistically: every action and inaction affects the security of the whole organisation.

11. Changes from previous versions

In this section, changes from the latest versions of Starviewer regarding previous versions that might impact system configuration or integration with the environment are explained.

11.1. PACS configuration

In version 2.0.0, support for WADO-type PACS (WADO-URI, WADO-RS, QIDO-RS, STOW-RS) has been added. This implies changes in the way to define available PACS and default PACS in the configuration.

11.1.1. New fields to add WADO PACS support

Starting from version 2.0.0, the following new fields are recognised in the PACS definition:

- Type: Indicates the type of PACS. Possible values: DIMSE, WADO, WADO-URI+DIMSE. If not specified, it is considered DIMSE to maintain compatibility with previous versions.
- BaseUri: Indicates the base URI for WADO and WADO-URI + DIMSE (hybrid) PACS.

Annex B contains the complete list of fields required for each type of PACS.

11.1.2. Default PACS

Until version 1.1.1, the list of default PACS was stored under the key PACS/defaultPACSListToQuery. From version 2.0.0, the key is PACS/defaultPACSListToQuery2 due to a format change in the key's content and switching between the two versions would be problematic. Starviewer automatically migrates the old key to the new one during the first execution. The old key is not deleted to avoid losing the list of default PACS if it is necessary to revert to the previous version of the program.

Section 1.4.2.2 explains the details of the format and content of this configuration.

11.2. Integration with RIS or SAP

In version 2.0.0, a new command-line option has been added to specify a study using a URL with a custom format, and Starviewer is automatically configured to handle URLs with this format. See sections 5.1 and 5.2 for more information.

Starting from version 2.0.0, it is not necessary to have the RIS listening port (5.4) activated for the command-line options to work.

12. Glossary

AE Title: *The AE Title (Association Entity Title) is the identifier used by the DICOM protocol to recognise the entities involved in image communication and transfer operations.* Thus, each PACS and workstation has its own AE Title associated with an IP address with which communications between them are negotiated.

DICOM: *DICOM (Digital Imaging and Communications in Medicine) is a standard for manipulating, storing, and transmitting medical image information.* The standard includes a definition of the DICOM file format and communication protocols, based on TCP/IP, allowing the exchange of information between two entities capable of sending and receiving information in DICOM format. DICOM was developed to enable integration and communication among scanners, radiographic devices, servers, workstations, and various hardware from different manufacturers.

DIMSE: *DIMSE (DICOM Message Service Element) is a set of services and protocols defined by DICOM to enable communication between different entities.* In this document we use DIMSE as a shorthand to refer to DIMSE-C.

DIMSE-C: *A subset of services and protocols of DIMSE that allows operations with composite instances.* It is the part of DIMSE most widely supported by different manufacturers.

PACS: *PACS (Picture Archiving and Communication System) is a system consisting of hardware and software dedicated to the storage, retrieval, management, distribution, and presentation of medical images.* The universal format for storing and transferring images is DICOM.

QIDO-RS: *QIDO-RS (Query based on ID for DICOM Objects by RESTful Services) is a WADO protocol that allows searching a PACS server using a RESTful HTTP URI.*

Query/Retrieve: *A DICOM service that allows a workstation to search for images and retrieve them from a PACS.*

Store: *A DICOM service used to send images or other persistent objects to a PACS or workstation.*

STOW-RS: *STOW-RS (STore Over the Web by RESTful Services) is a WADO protocol that allows sending DICOM objects (instances, series, or studies) to a server using a RESTful HTTP URI.*

WADO: *WADO (Web Access to DICOM Objects) is a set of services and protocols defined by DICOM to enable communication between different entities based on web technologies (HTTP, JSON, etc.).* The related term DICOMweb refers to the subset of services and protocols that are RESTful. When we use the term WADO in this document, we refer to WADO-URI, WADO-RS, QIDO-RS, and STOW-RS.

WADO-RS: *WADO-RS (Web Access to DICOM Objects by RESTful Services) is a WADO protocol that allows downloading DICOM objects (instances, series, or studies) from a server using a RESTful HTTP URI.*

WADO-URI: *WADO-URI (Web Access to DICOM Objects by URI) is a WADO protocol that allows downloading individual DICOM instances from a server using an HTTP URI.*

A. Annex A: Example of PACS list configuration

In this example, we have the configuration for 3 PACS with the local port 4007.

Windows

```
[HKEY_CURRENT_USER\Software\GILab\Starviewer\PACS\pacsparam]
"localPort"="4007"

[HKEY_LOCAL_MACHINE\Software\GILab\Starviewer\PacsList]
"size"=dword:00000003

[HKEY_LOCAL_MACHINE\Software\GILab\Starviewer\PacsList\1]
"AETitle"="PACS1"
"Description"="PACS 1 (DIMSE)"
"ID"="0"
"Institution"="Hospital 1"
"Location"="Local 1"
"PacsHostname"="10.0.0.1"
"PacsPort"=dword:00002b68
"QueryRetrieveServiceEnabled"="true"
"StoreServiceEnabled"="true"
"StoreServicePort"=dword:00002b68
"Type"="DIMSE"

[HKEY_LOCAL_MACHINE\Software\GILab\Starviewer\PacsList\2]
"BaseUri"=hex:40,00,56,00,61,00,72,00,69,00,61,00,6e,00,74,00,28,00,00,00,00,\
  00,00,00,11,00,00,00,00,00,00,00,15,00,68,00,74,00,74,00,70,00,3a,00,2f,00,\
  2f,00,31,00,30,00,2e,00,30,00,2e,00,30,00,2e,00,32,00,2f,00,77,00,61,00,64,\
  00,6f,00,2f,00,29,00
"Description"="PACS 2 (WADO)"
"ID"="1"
"Institution"="Hospital 2"
"Location"="Local 2"
"Type"="WADO"

[HKEY_LOCAL_MACHINE\Software\GILab\Starviewer\PacsList\3]
"AETitle"="PACS3"
"BaseUri"=hex:40,00,56,00,61,00,72,00,69,00,61,00,6e,00,74,00,28,00,00,00,00,\
  00,00,00,11,00,00,00,00,00,00,00,19,00,68,00,74,00,74,00,70,00,3a,00,2f,00,\
  2f,00,31,00,30,00,2e,00,30,00,2e,00,30,00,2e,00,33,00,2f,00,77,00,61,00,64,\
  00,6f,00,2d,00,75,00,72,00,69,00,2f,00,29,00
"Description"="PACS 3 (WADO-URI + DIMSE)"
"ID"="2"
"Institution"="Hospital 3"
"Location"="Local 3"
"PacsHostname"="10.0.0.3"
"PacsPort"=dword:00002b68
"QueryRetrieveServiceEnabled"="true"
"StoreServiceEnabled"="true"
"StoreServicePort"=dword:00002b68
"Type"="WADO-URI+DIMSE"
```

Linux

```
[PACS]
```

```
pacsparam\localPort=4007

[PacsList]
1\AETitle=PACS1
1\Description=PACS 1 (DIMSE)
1\ID=0
1\Institution=Hospital 1
1\Location=Local 1
1\PacsHostname=10.0.0.1
1\PacsPort=11112
1\QueryRetrieveServiceEnabled=true
1\StoreServiceEnabled=true
1\StoreServicePort=11112
1\Type=DIMSE
2\BaseUri=@Variant(\0\0\0\x11\0\0\0\x15http://10.0.0.2/wado/)
2\Description=PACS 2 (WADO)
2\ID=1
2\Institution=Hospital 2
2\Location=Local 2
2\Type=WADO
3\AETitle=PACS3
3\BaseUri=@Variant(\0\0\0\x11\0\0\0\x19http://10.0.0.3/wado-uri/)
3\Description=PACS 3 (WADO-URI + DIMSE)
3\ID=2
3\Institution=Hospital 3
3\Location=Local 3
3\PacsHostname=10.0.0.3
3\PacsPort=11112
3\QueryRetrieveServiceEnabled=true
3\StoreServiceEnabled=true
3\StoreServicePort=11112
3\Type=WADO-URI+DIMSE
size=3
```

If the local AE Title could be parametrised, we could include it within the same file. For example, if the AE Title consists of the constant WORKSTATION concatenated with the last 3 digits of the IP, filling in the spaces with 0 when the number has fewer than 3 digits, we would add:

Windows

```
[HKEY_CURRENT_USER\Software\GILab\Starviewer\PACS\pacsparam]
"AETitle"="WORKSTATION%IP.4%[3:0]"
```

Linux

```
[PACS]
pacsparam\AETitle=WORKSTATION%IP.4%[3:0]
```

B. Annex B: Description of parameters defining a PACS server

Next, we describe the meaning of each attribute that defines a PACS server and what its possible values are.

ID

Identifier of the PACS in the list. The identifiers are consecutive natural numbers and start at 0, that is, for the first PACS it is 0, for the second, 1, etc.

Type

Type of PACS. Possible values: DIMSE, WADO, WADO-URI+DIMSE. If not indicated, it is considered DIMSE. The type of PACS determines which connection parameters are necessary. If a non-necessary parameter is indicated in a PACS, it is ignored.

The necessary attributes for each type of PACS are as follows:

- DIMSE: ID, Type, AETitle, PacsHostname, QueryRetrieveServiceEnabled, PacsPort, StoreServiceEnabled, StoreServicePort, Institution, Location, Description.
- WADO: ID, Type, BaseUri, Institution, Location, Description.
- WADO-URI + DIMSE: ID, Type, AETitle, PacsHostname, QueryRetrieveServiceEnabled, PacsPort, StoreServiceEnabled, StoreServicePort, BaseUri, Institution, Location, Description.

AETitle

AE Title of the PACS server. It is the name with which the PACS server identifies itself to clients. Only used in DIMSE and WADO-URI + DIMSE PACS.

PacsHostname

IP address or machine or domain name of the PACS server. Only used in DIMSE and WADO-URI + DIMSE PACS.

QueryRetrieveServiceEnabled

A boolean indicating whether the Query/Retrieve service is enabled or not for this PACS, i.e., if it allows searches and downloading studies. Possible values: true, false. Only used in DIMSE and WADO-URI + DIMSE PACS.

PacsPort

Port of the PACS server where it will receive Query/Retrieve requests. Possible values: a natural number in the range [0, 65535]. Only used in DIMSE and WADO-URI + DIMSE PACS.

StoreServiceEnabled

Indicates whether the Store service is enabled or not for this PACS, i.e., if it allows sending studies. Possible values: true, false. Only used in DIMSE and WADO-URI + DIMSE PACS.

StoreServicePort

Port of the PACS server where it will receive Store requests. Possible values: a natural number in the range [0, 65535]. Only used in DIMSE and WADO-URI + DIMSE PACS.

BaseUri

Base URI of a WADO or WADO-URI + DIMSE server. It serves as a base for forming URIs for all requests. Possible values: any valid URI. Only used in WADO and WADO-URI + DIMSE PACS.

It should be noted that it is not stored in text format but in a format that Qt uses to represent a QVariant. On Linux, it is relatively easy to edit if the structure is known because it is represented as text, but on Windows, it is a slightly more complex sequence of bytes. If you want to define it at the system level, the easiest way is to edit it at the user level from Starviewer and then export it with RegEdit and copy its value. We leave an explanation below in case you want to understand how it works.

The base URI of the second PACS in the examples in Annex A is `http://10.0.0.2/wado/`. In Linux, this is represented as follows: `@Variant(\0\0\0\x11\0\0\0\x15http://10.0.0.2/wado/)`. The structure is explained in the table below.

On Windows, the same is stored with a binary representation in UTF-16LE. That is, for example, the first character, `@`, in UTF-16 is `0040`; since it is little endian, the smallest byte is represented first, i.e., `4000`. This also applies to each individual byte: for example, the byte represented as `\x11` in the previous example, in UTF-16 would be `0011` and in UTF-16LE `1100`. In other words, each original byte in this step is saved in 2 bytes, and the second is always 0.

The table below explains in detail the structure of the format and the representation in each case.

Part	Value	Text	UTF-16LE
Begin QVariant	@QVariant(	@QVariant(	40 00 56 00 61 00 72 00 69 00 61 00 6e 00 74 00 28 00
Qvariant type = QUrl	0x11	\0\0\0\x11	00 00 00 00 00 00 11 00
URL length	21 (0x15)	\0\0\0\x15	00 00 00 00 00 00 15 00
URL	http://10.0.0.2/wado/	http://10.0.0.2/wado/	68 00 74 00 74 00 70 00 3a 00 2f 00 2f 00 31 00 30 00 2e 00 30 00 2e 00 30 00 2e 00 32 00 2f 00 77 00 61 00 64 00 6f 00 2f 00
End QVariant	)	)	29 00

Institution

Indicates the institution to which the PACS server belongs. Free text.

Location

Indicates the location of the PACS server. Free text.

Description

Textual description of the server. It is the description that identifies the PACS to the user. Free text.