To configure your workstation as DICOM compliant, first select *Preferences* from the Horos contextual menu (Fig 9.2). Then you will require:

- A fixed IP address to allow your workstation to be configured as a DICOM receiver node
- A DICOM AE title. This is essentially a name you give your workstation software to identify it e.g. Horos

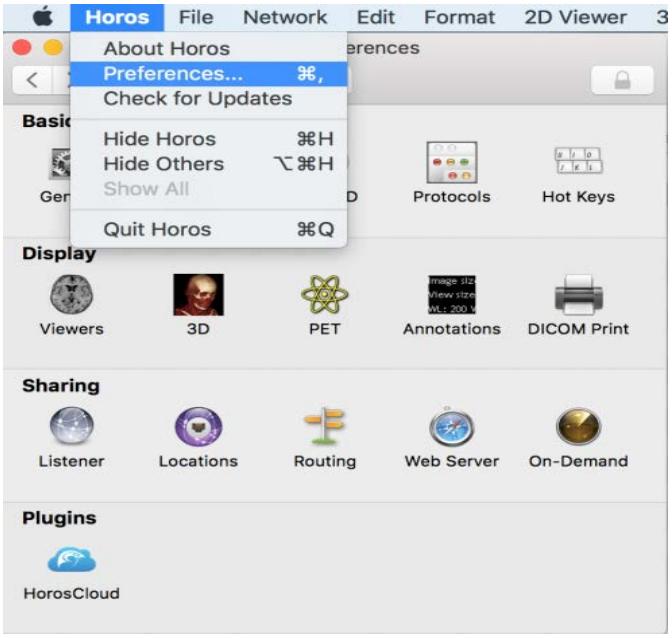
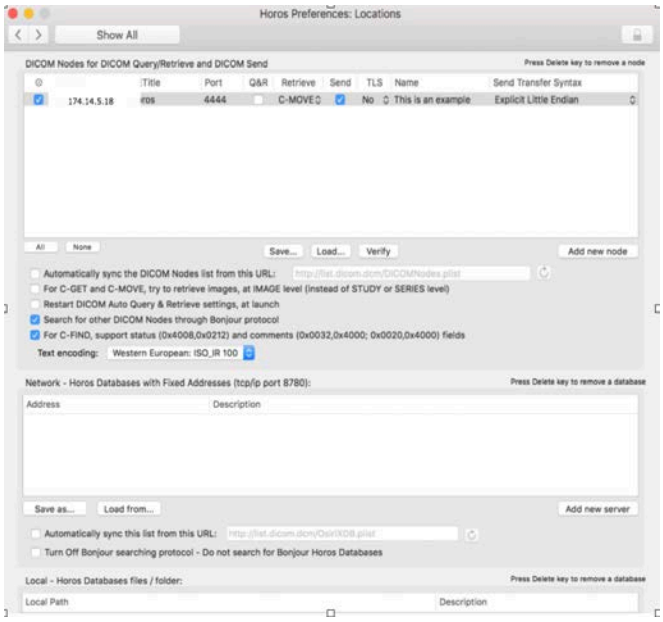


Figure 9.2 The Preferences window

DICOM Nodes - The DICOM node list

A DICOM node describes any networked DICOM software or hardware, which is used to manage, process or transfer DICOM images. This is essentially a workstation or PACS server. Each DICOM node is uniquely identified by the TCP/IP address of the computer e.g. 174.14.5.18 as well as the TCP/IP Port e.g. 4686 and its Application Entity (AE) title e.g. Horos.



In order to connect to a PACS server or another DICOM compatible workstation you will need to identify those devices/computers or software. Once this has been done you will be able to send a *Query* and then *Retrieve* images. This is done using their IP address and DICOM identifiers.

To do this, open the *Locations* tab within *Preferences*, in the Horos contextual menu (Fig 9.3), then check the box to the DICOM node you wish to identify. These are found at the top of the window.

Figure 9.3 The Locations Preferences window

It is possible to set up Horos to connect to multiple devices from which you can retrieve images and send images.

You will need to ensure your workstation is:

- Authorized to connect to these devices (nodes)
- That these devices are authorized to respond to the *Query* generated by your workstation
- The appropriate settings and privileges in your workstation have been setup

Contact your PACS administrator in the first instance for assistance with us. The Horos support team are also happy not help.

It is possible to use Horos as a PACS server whereby other workstations can retrieve images from your Horos database.

This function is performed through the C-MOVE SCP protocol. To enable this, the workstations must appear in the list of DICOM nodes in the *Locations Preferences* window.

If a distant workstation (DICOM node) sends a *Query (*C-MOVE SCU) to your workstation, it will fail unless that workstation is listed as a DICOM Node in your *Locations Preferences* window. To respond to the *Query*, Horos needs the TCP/IP address, port number and the AE title.

Query & Retrieve

The Query tool, available on the toolbar, allows you to search for, and retrieve, images from any source which is DICOM compliant. This includes PACS servers and other Horos workstations that you are authorized to access. You can then store, load and process these images in Horos. You can also access the Query tool via the Network contextual menu (Fig 9.4).

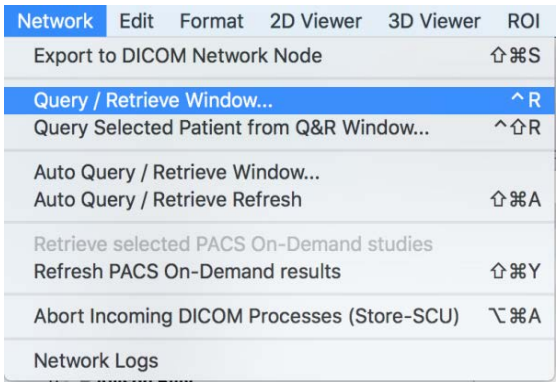


Figure 9.4 The Network contextual menu displaying the Query/Retrieve window function

Entering a Query

The default search criterion is patient name (fig 9.5(i)). When all or part off the name is entered, Horos searches all compliant sources for matching DICOM files. These may be local, external or on a networked server. It is possible to set limiting criteria to narrow the search results, such as acquisition time or study type. Matching files will be displayed in a list at the bottom of the search window. See Chapter 4 for more details.

When entering a query, a less restrictive or empty filter may take longer to return a result, particularly if the matching study is stored at a distant DICOM node.

Available DICOM Nodes (PACS and other workstations)

Available DICOM nodes, representing a PACS or workstation, are visible in the upper left box of the *Query/Retrieve* window (Fig 9.5(ii)). To select single or multiple nodes, simply check the box to the left of each named node.

The priority order of the nodes, i.e. the order in which they are listed, determines which node is used to retrieve a study. The node with the highest priority is always used and this is important if the study is stored at multiple nodes.

The priority order can be changed by selecting a line and dragging and dropping it. This is done by selecting the desired line and holding your finger on the mouse/mousepad whilst moving the cursor to the desired location.

To define your preferences for the DICOM nodes list, go to *Locations Preferences.* See Chapter 2 for more details.

Sending to an alternative workstation

To send the retrieved files to a workstation other than your own, select the desired DICOM node from the *Retrieve* list. This is found in the drop down menu box, immediately below the list of DICOM nodes (fig 9.5(iii)). It is important to note that this option only works if the selected DICOM Node has been setup to use the C-MOVE SCU protocol. See Chapter 2 for more details.

Retrieving the images

Once the list of matching studies, series or images are displayed in the box at the bottom of the window (fig 9.5(iv)). There are four main ways to retrieve and display the image (s):

- Double click on the desired line
- Select the desired line(s) and press *Retrieve*
- Select the desired line(s) and press *Return* on your keyboard
- Press the *Green Arrow* button in the first column of the list

Once the desired lines are selected, Horos will download and store the images in the *Horos Data* folder, whilst also indexing them in the database. This is performed as a background thread, which will appear in the activity box of the left hand side panel of the database window.

The added images will now appear on the study list and can be selected and processed as desired.

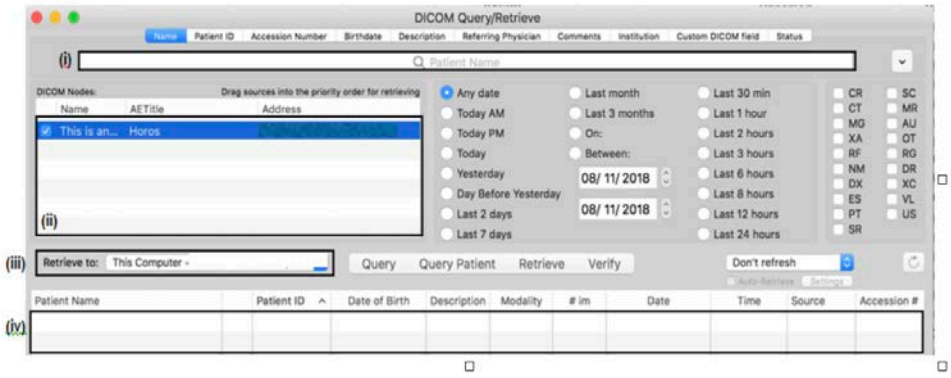


Figure 9.5 DICOM 'Query' window showing the *Query* box (i), available DICOM Nodes (ii), Retrieve box (iii) and the results box (iv)

The protocols used by Horos to perform and Query & Retrieve are:

- C-FIND SCU - to search for a study
- C-MOVE/C-GET SCU - C-STORE SCP - to retrieve the images

Note: WADO HTTP is an alternative protocol used by Horos to retrieve the images.

DICOM protocols continued

As described earlier in this chapter, in order to perform services on a DICOM network and communicate with other PACS and workstations, Horos employs and supports a number of recognized DICOM protocols. These protocols are described in the DICOM Standard [10].

In the case of a Service Class Provider (SCP), where the software or hardware acts as a server and is described as 'offering a service', these protocols are 'always-up' and ready to respond to a request.

In the case of a Service Class User (SCU), these protocols only run when a task or the tool is triggered by the user.

A list of the protocols supported by Horos is displayed below:

Protocol Name	**SCU/SCP**	**Description**
C-STORE	Both	Listener and Send Functions
C-FIND	Both	Image Queries*
C-MOVE	Both	Image retrieval*
C-GET	Both	Image retrieval*
C-ECHO	Both	DICOM Nodes test functions*
C-PRINT	SCU	DICOM printing
WADO	Both	HTTP Web protocol for image transfer

** These protocols are run through the Query and Retrieve Window*

Some or all of the protocols can be selected to run by you as the Horos user. Where this is the case a dialogue window, or graphic user interface (GUI), will be available to access for this purpose. The following table outlines how this can be done:

Protocol Name	**Graphic User Interface**	**Location of Setup**
C-STORE SCP	Always-up, No GUI	*Listener Preferences*
C-FIND SCP	Always-up, No GUI	No preferences
C-MOVE SCP	Always-up, No GUI	*Locations Preferences*
C-GET SCP	Always-up, No GUI	*Listener Preferences*
C-ECHO SCP	Always-up, No GUI	*Locations Preferences*
C-STORE SCU	SENDing, ROUTing	*Locations Preferences*
C-FIND SCU	Query/Retrieve Window	Q/R Window Settings
C-MOVE SCU	Query/Retrieve Window	Q/R Window Settings

C-GET SCU	Query/Retrieve Window	Q/R Window Settings
C-ECHO SCU	Query/Retrieve Window	*Locations Preferences*
C-PRINT SCU	Printing	Print Preferences
WADO	No GUI	*Locations Preferences*

The proceeding sections describe in greater detail each of the DICOM protocols.

Store Service Class Provider (C-Store SCP) - DICOM Listener

The DICOM Listener is the process of writing, or transferring, DICOM images and the associated files into the *INCOMING* folder of the *Horos Data* folder. From here the files are added to the database at regular intervals. The DICOM listener is able to download multiple images concurrently.

The DICOM Listener is a protocol which runs as a background thread when Horos is launched. It is known as the C-STORE Service Class Provider (C-STORE SCP). Upon launch of Horos, if the DICOM Listener has been activated, the C-STORE SCP is launched. See Chapter 2 for further details on activating and other options for the DICOM Listener.

Once the C-STORE SCP has identified incoming files, a separate 'forked' process commences. The outcome of this is that the C-STORE thread will continue to run in the background irrespective of other functions being undertaken within Horos and cannot be blocked by other actions of the Horos user.

Should the C-STORE SCP protocol crash, due to corrupted data for example, only this protocol will be affected and the Horos application will continue to function. No error message will be displayed. It is the Service Class User (SCU) which is responsible for generating the error message.

A number of options can be selected within the *Listener* found in *Preferences* (Fig 9.6a). Further details on these options can be found in Chapter 2. A number of options to be aware of are:

Activate DICOM Listener - Checking this option urns on the DICOM listener

Accept only one association at a time - It is recommended that you leave this option unchecked, otherwise the number of simultaneous image downloads is limited

Generate logs for DICOM Network events - This option logs each time a C-STORE SCP association occurs. The log is stored in the Network Logs file

Preferred Syntax - This option allows you to select which DICOM storage format will be accepted. The default setting for this is Explicit Little Endian (Fig 9.6b)

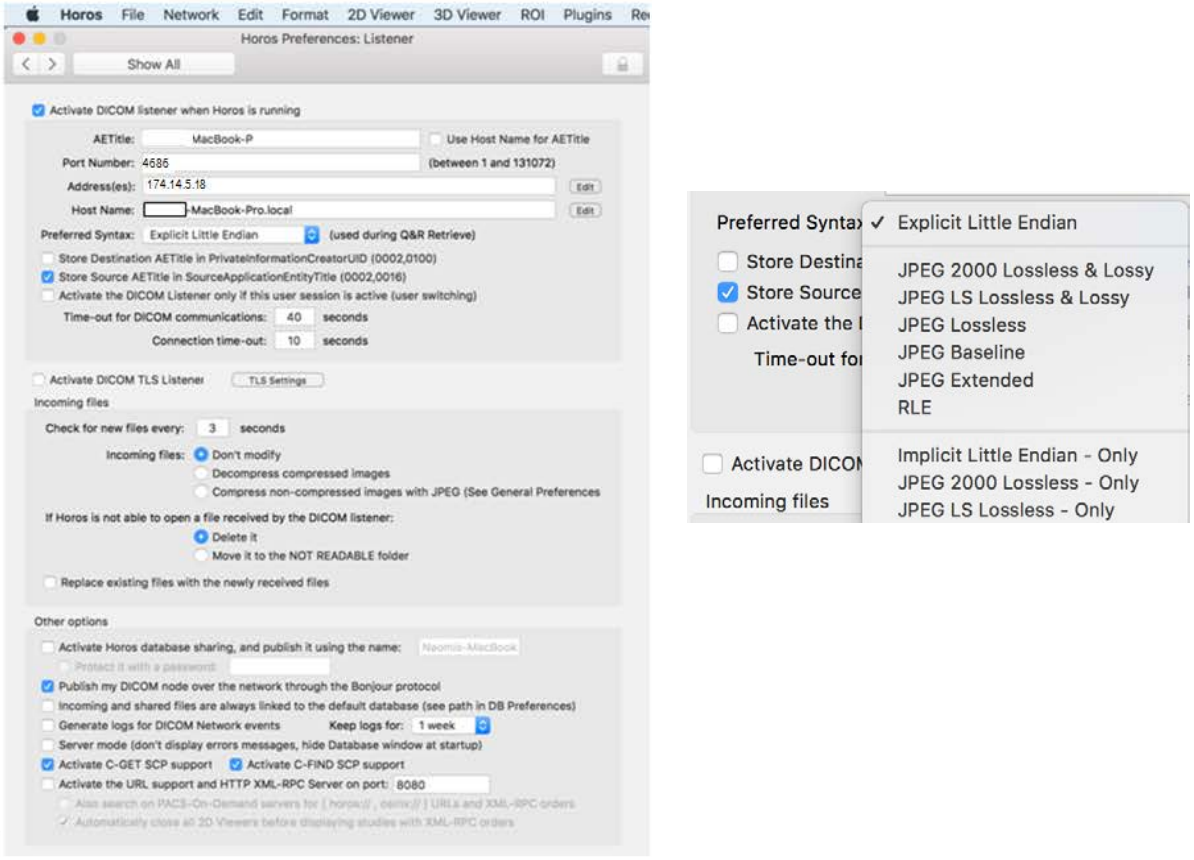


Figure 9.6 The Listener Preferences window (a) and the Preferred Syntax options (b)

Store Service Class User (C-STORE SCU) DICOM Send

DICOM Send (C-STORE SCU) is the protocol by which images can be sent from an imaging modality, from one user to another or to a PACS. Just like the S-STORE SCP it runs as a background thread, however it differs in that it is not 'forked' as a separate process. This means that the send protocol can be blocked or stalled if the user is concurrently undertaking actions, such as deleting files. Once the user has finished these actions and the database has essentially been restored, the DICOM send protocol will automatically resume.

Each DICOM Send order is queued, so only one C-STORE SCU association is created at a time. You will see these displayed in the *Activity* section of the left hand side panel. It is possible to alter this preference in the dialogue window which appears when the *SEND* tool is selected from the toolbar. A number of other options can be chosen from this dialogue window (Fig 9.8).

In contrast to the C-STORE SCP, an error message will appear if the *SEND* function fails.

If you wish to log each C-STORE SCU association, this can be selected in the *Preferences.* The log is stored in the *Network Logs* file. See Chapter 2 for more details.

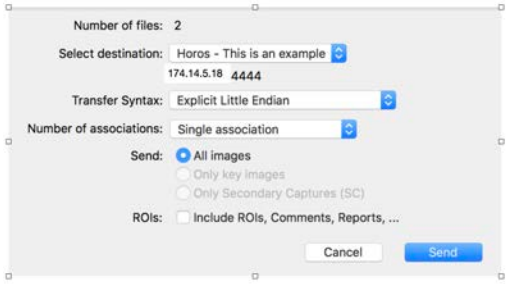
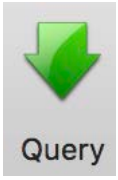


Fig 9.8 *SEND* Dialogue window with options

FIND Service Class Provider (C-FIND SCP)

Query



The query tool allows you to search for, and retrieve, images from any source which is DICOM compliant (Fig 9.9). The default search criterion is patient name. When all or part off the name is entered, Horos searches all compliant sources for matching DICOM files. These may be local, external or on a networked server. It is possible to set limiting criteria to narrow the search results, such as acquisition time or study type. Matching files will be displayed in a list at the bottom of the search window. See Chapter 4 for more details.

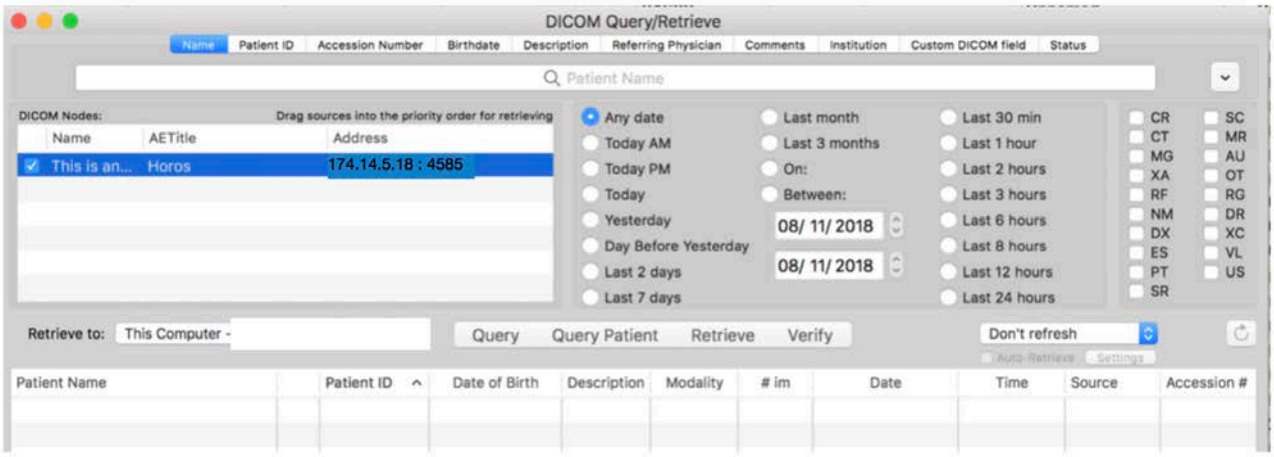


Figure 9.9 DICOM 'Query' window

When the *Query* tool is selected from the toolbar a database containing the query criteria is sent from the service class user (SCU) to the service class provider (SCP). The information contained within the query dataset has one of two attributes:

- Data to be matched, i.e. this with a value filled in such as patient ID
- Data to be returned, i.e. those left blank

The service class provider (SCP) responds by identifying matching datasets i.e. those studies or series which match the search criteria and sending them back to your Horos database. Queries are accepted at the study, series or image level, but not at the patient level.

Upon launch of Horos, if the DICOM Listener has been activated, the C-FIND SCP is launched. See Chapter 2 for further details on activating and other options for the DICOM Listener.

Once the C-FIND SCP is launched and an association is started, in a similar way to the C-STORE SCP, a separate 'forked' process commences. The outcome of this is that the C-FIND thread will continue to run in the background irrespective of other functions being undertaken within Horos and cannot be blocked by other actions of the Horos user.

Should the C-FIND SCP protocol crash, due to corrupted data for example, only this protocol will be affected and the Horos application will continue to function. No error message will be displayed. It is the Service Class User (SCU) which is responsible for generating the error message.

Once a C-FIND query is successfully generated, the query is applied in a SQL format, to either the current database for the default database. This can be altered in *Database Preferences*, see chapter 2.

Unlike the C-STORE SCP, C-FIND SCP events are not logged. The corresponding C-MOVE and C-GET events are logged however.

Three transfer syntaxes, or encoding rules, are utilised for this function. They are, in order of priority:

LittleEndianExplicitTransferSyntax	0
BigEndianExplicitTransferSyntax	1
LittleEndianImplicitTransferSyntax	2

Find Service Class User (C-FIND SCU)

The C-FIND SCU protocol is used by both the Query Tool, see chapter 4, and the auto-routing engine. The same transfer syntaxes, or encoding rules apply, as for the C-FIND SCP, described above.

In contrast to the C-FIND SCP, an error message IS generated if the C-FIND SCU fails.

In contrast to the C-FIND SCP, a query can be generated at the study or series level, but not at the patient level. Similarily, it is also not compatible at the image level.

When using the *Query* tool, Horos can generate a C-FIND protocol for the following DICOM fields (see fig 9.4 on the previous page):

- -Name
- -Patient ID
- -Accession number
- -Birthdate
- -Description
- -Referring physician
- -Comments
- -Institution
- -Custom DICOM field
- -Status

Similar to the C-FIND SCP, events are not logged. The corresponding C-MOVE and C-GET events are logged however.

Move Service Class Provider (C-MOVE SCP

Upon launch of Horos, if the DICOM Listener has been activated, the C-MOVE SCP launches. See Chapter 2 for further details on activating and other options for the DICOM Listener.

This allows the C-MOVE SCP to act as a C-STORE SCU and to copy composite instances to a requested AE Title which may or may not be the original C-MOVE SCU.

Once the C-MOVE SCP is launched and an association is started, in a similar way too the C-STORE SCP, a separate 'forked' process commences. The outcome of this is that the C-MOVE thread will continue to run in the background irrespective of other functions being undertaken within Horos and cannot be blocked by other actions of the Horos user.

Should the C-MOVE SCP protocol crash, due to corrupted data for example, only this protocol will be affected and the Horos application will continue to function. No error message will be displayed. It is the Service Class User (SCU) which is responsible for generating the error message.

In the same way as the C-FIND SCP, queries are accepted at the study, series or image level, but not at the patient level.

If the Networks logs function has been activated, see Chapters 2 and 9, each C-MOVE SCP is logged within the Network Log file.

The same transfer syntaxes, or encoding rules, are used as for the C-FIND SCP, described above.