Using DICOM Hanging Protocols to Create a Multi-Discipline DICOM Viewer

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LEAD TECHNOLOGIES INCORPORATED

1 Introduction

There is no question that DICOM Hanging Protocol is an important feature for busy physicians. One only needs to look at the vast number of display layout options offered by different applications, and to the specialized views for different medical disciplines such as radiology, cardiology, mammography, dental, etc. Naturally, these specialized viewing preferences for various specialties has led to equally specialized software. That is great for individual practices, but in a larger setting such as a hospital, all this disparate software creates additional costs since each department needs its own viewer, and possibly even its own PACS. What if there was a better, faster, and more cost-efficient way for every physician, technician, nurse, and patient to view their images easily and intuitively using a single viewer application with all the institution's images stored in a single archive?

This is not a new problem. In fact, the DICOM Standards Committee addressed this concern by defining Hanging Protocols in Supplement 60 back in 2004:

> *"The objective [of DICOM Hanging Protocols] is for a radiologist, or a department, to be able to set up Hanging Protocols for a variety of reading situations on one workstation, and have the capability to have those Hanging Protocols available on several other workstations, independent of the manufacturer."*

More simply, doctors can "hang" their digital images on their screen, and then save the layout and viewing preferences for reuse. It's much more than just a reusable display layout though; DICOM Hanging Protocols can be used by any user with proper access rights, on any viewer, and with any compatible set of images!

Why then, after more than a decade, is DICOM Hanging Protocol such a difficult feature to find? Truth be told, it's difficult and complex. Realizing the importance of a standardized way to save and reuse layouts, the DICOM Standards committee created another specification in 2008 that is easier to implement: Structured Display (Supplement 123). This is more straightforward because a Structured Display is based on the instances of a single patient. It is a great way to recall the same view, share with another doctor in the same practice, or even embed on a CD viewer for the patient. However, the same distinction that makes Structured Display simpler also makes it fall vastly short of its potential for creating an interoperable and living digital health care ecosystem.

An argument can also be made that Hanging Protocol was before it's time. Its drafting was ambitious given the fact that dial-up and CRT monitors were still on the market as viable products. In addition to the rapid advancement of computer displays and networking, today's health care system is also seeing a shift towards VNAs (vendor-neutral archives). Hanging Protocols can and should be a major piece of the puzzle when implementing a VNA for a hospital or large medical organization.

Does implementing DICOM Hanging Protocol still sound like an insurmountable challenge that's not worth the effort? It doesn't have to be! There are software development tools that can nearly eliminate the learning curve surrounding Hanging Protocols and help you produce a shipping product in a fraction of the time. In particular, LEADTOOLS has developed a cross-platform Medical Viewer with DICOM Hanging Protocol support that can be used with any third-party PACS.

Using DICOM Hanging Protocols in LEADTOOLS

LEADTOOLS Medical Imaging SDKs remove much of the hassle out of implementing DICOM Hanging Protocols. In fact, software developers hardly have to do a thing because it's a built-in feature of the LEADTOOLS HTML5 Zero-Footprint Medical Viewer. This incredible viewing framework is fully customizable, and handles everything required for both in-office and remote viewing on any workstation or device with an HTML5-compatible web browser.

Rather than writing a script or manually selecting and assigning values to tags with a DICOM Data Set creation tool, end-users and admins can create their Hanging Protocols visually. All they need to do is click and drag images into the study layout, and set tools preferences to their liking and click save. The Hanging Protocol wizard will then guide the user through the tags used for querying the PACS and selecting images to place into the layout. Most DICOM tags are deciphered from your current layout: Number of cells and subcells, scrolling type, modality, body part examined, study description, etc. Users can easily remove these pre-selected tags for a broader match, or add precise selection criteria by selecting from a list of allowable DICOM tags and manually entering values. Once saved, the user can load the Hanging Protocol by right-clicking on the study in the search screen to display a context dialog with all the Hanging Protocols compatible with the study.

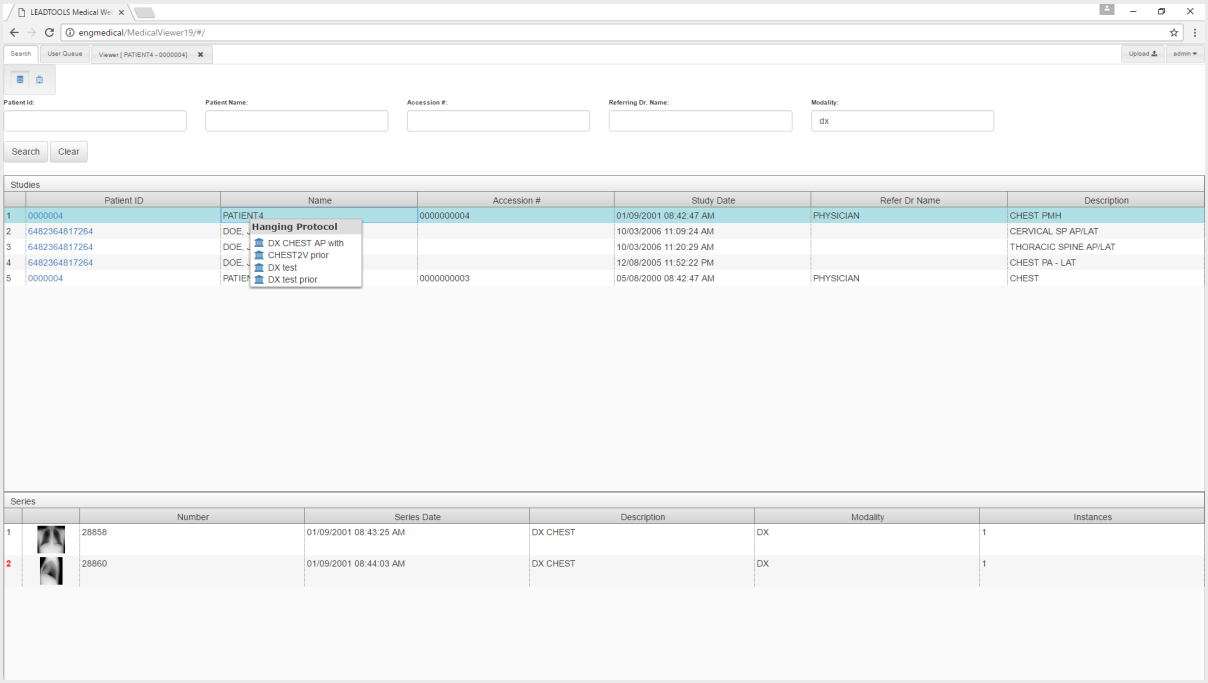

Figure 1: Right-click dialog on search results showing available Hanging Protocols to apply.

Below are just a few examples of Hanging Protocols you can create with the LEADTOOLS Zero-footprint Medical Viewer.

Hanging Protocol Example 1: Compare Current and Prior X-Ray

Follow-up visits are very common, therefore a way to compare the current study with prior studies is an incredibly useful, time-saving Hanging Protocol for physicians. Rather than searching for multiple studies and loading them one at a time into the viewer, a DICOM Hanging Protocol can find the desired number of prior studies on the same body part and display them side by side for proper examination.

1. Identify a patient with multiple studies taken on different dates, and load the desired image or series from the current study into the viewer.

2. Set the Study Layout to 1x2 (Rows x Columns).

3. Click the Compose Layout button to bring up the study timeline thumbnail browser on the bottom of the screen. Find the matching image with a date older than the current study and drag it into the empty cell.

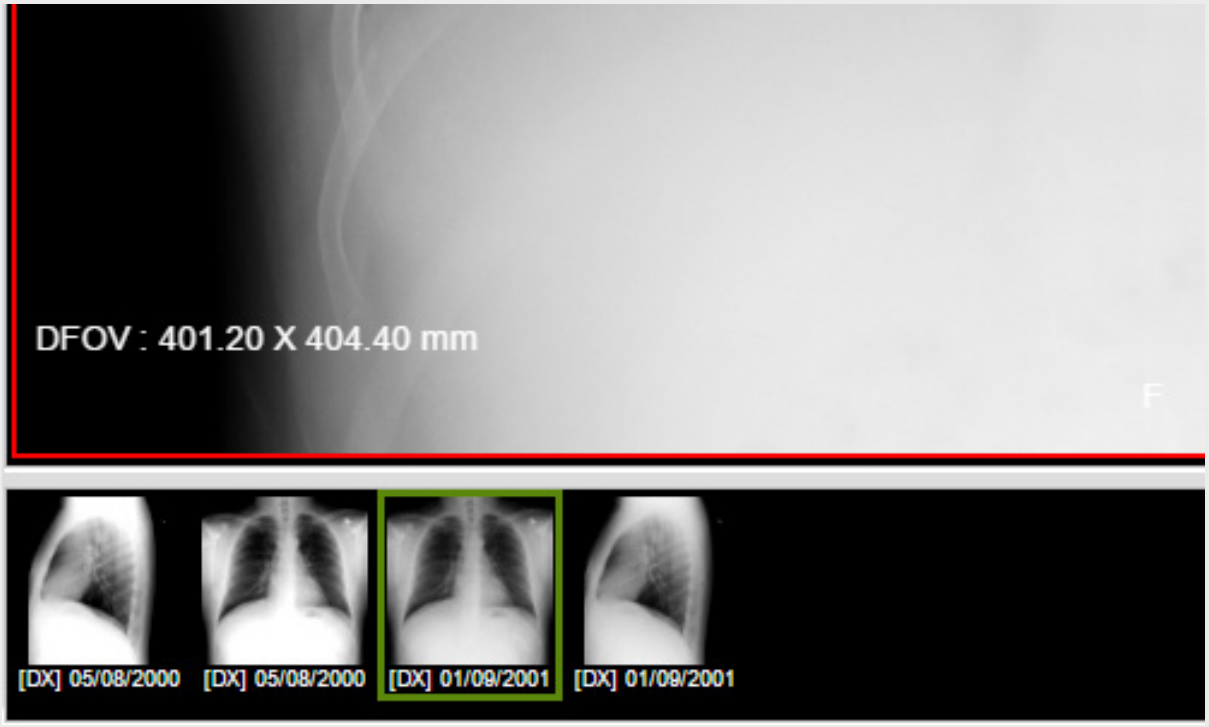

Figure 2: Close-up of the Study Timeline. Note the dates of each series that will aid in selecting the correct prior.

4. Click the Save Hanging Protocol button and proceed through the wizard, giving it a name and description on the first screen. The second screen, Hanging Protocol Definitions, generates the Hanging Protocol sequence, which serves as the primary selector when choosing which Hanging Protocols are available to the user when right-clicking on a study. More often than not, this requires no further tweaking since it automatically detects the Modality and Body Part Examined from the DICOM tags in the displayed images.

5. Third is the Hanging Protocol Settings dialog is the Image Sets page, which defines how to select the images within the study. The pre-populated values here are also very reliable. However, some care should be taken with tags like Study Description since they might be free-text fields at some practices and any variance or typo could cause a mismatch. Most importantly for this example is the Time Based Image Sets area, where you can define how priors are selected. We will take the default of 1 prior, but it's also possible to alter the minimum and maximum number of priors.

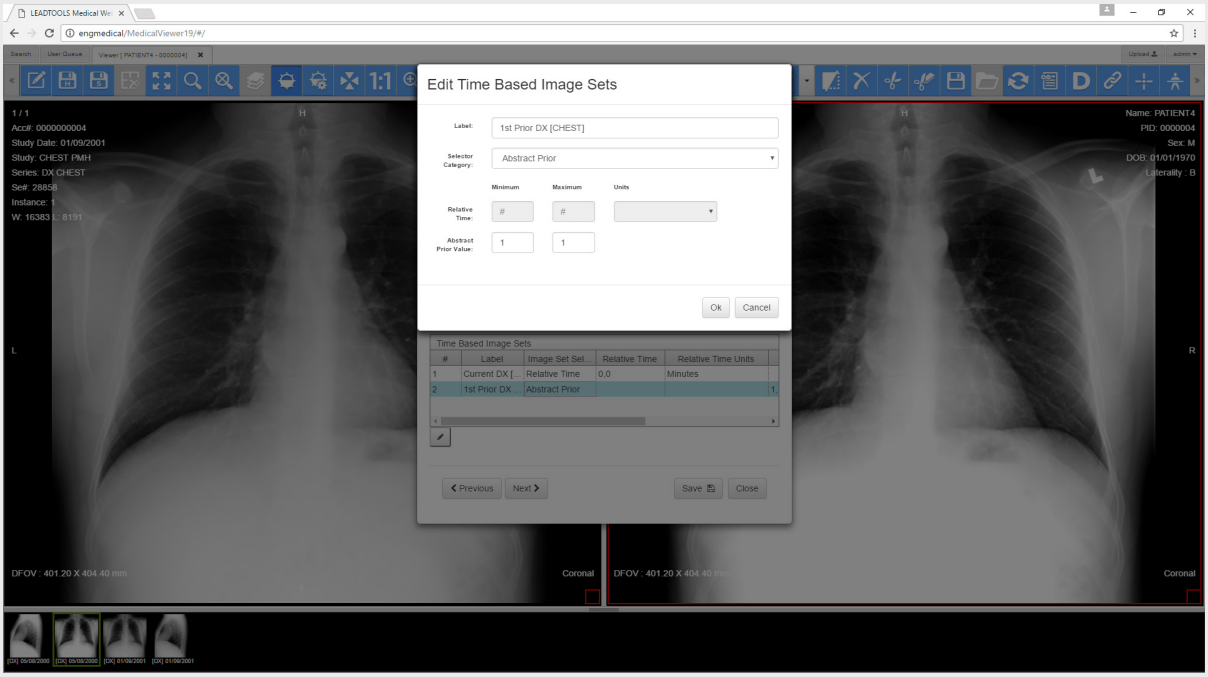

Figure 3: Configuring the Priors in the Hanging Protocol Settings dialog.

6. Finally, the Display Sets in each study layout cell can be fine-tuned as well. This is an important step for this study since, as shown in the study timeline, both back and side images were captured. Without defining the Image Laterality tag with a value of B, the Hanging Protocol might select one of the side-view images.

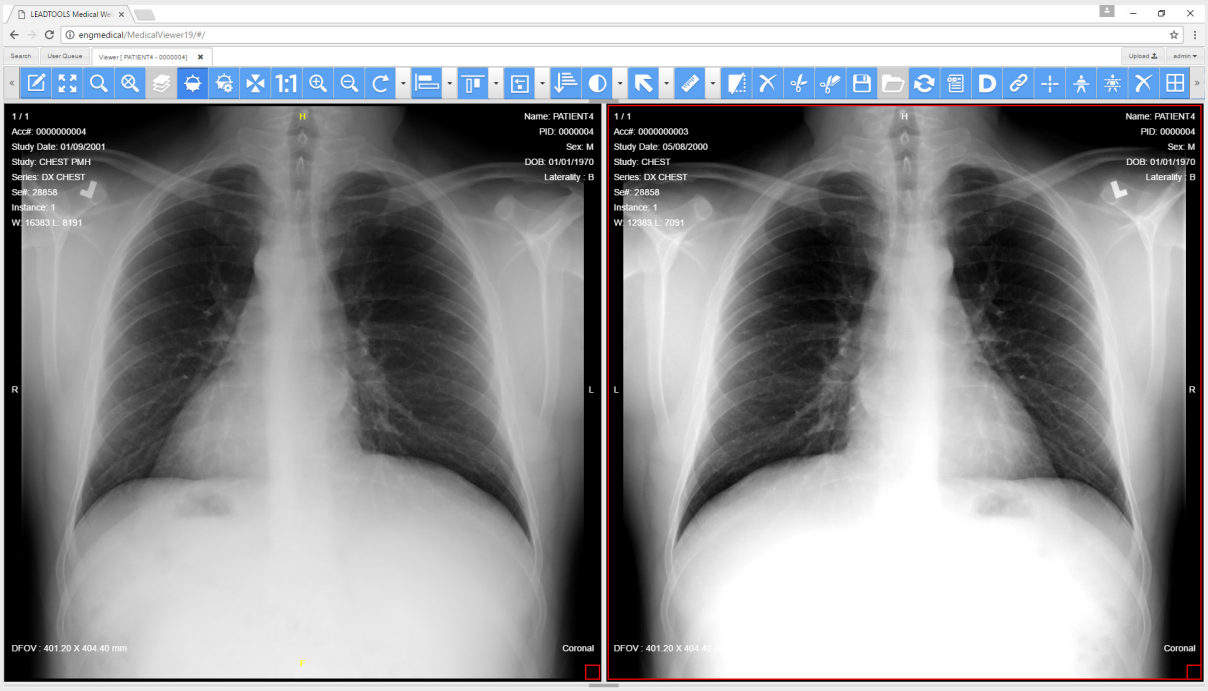

Figure 4: Applying the new Hanging Protocol to a patient with multiple studies.

Hanging Protocol Example 2: Multiple MRI Priors

DICOM Hanging Protocols have their home outside of radiology as well. For example, MRI studies often require follow-up visits as well to check on the progression of a condition. Hanging Protocols are flexible enough both to pick and display a variable number of priors. For example, the same Hanging Protocol could be used on a patient with 5 studies over the course of many years and a patient with only 3 studies. In each case, it will start at whichever study was selected as the current and go back in time finding the studies with matching criteria, as shown below:

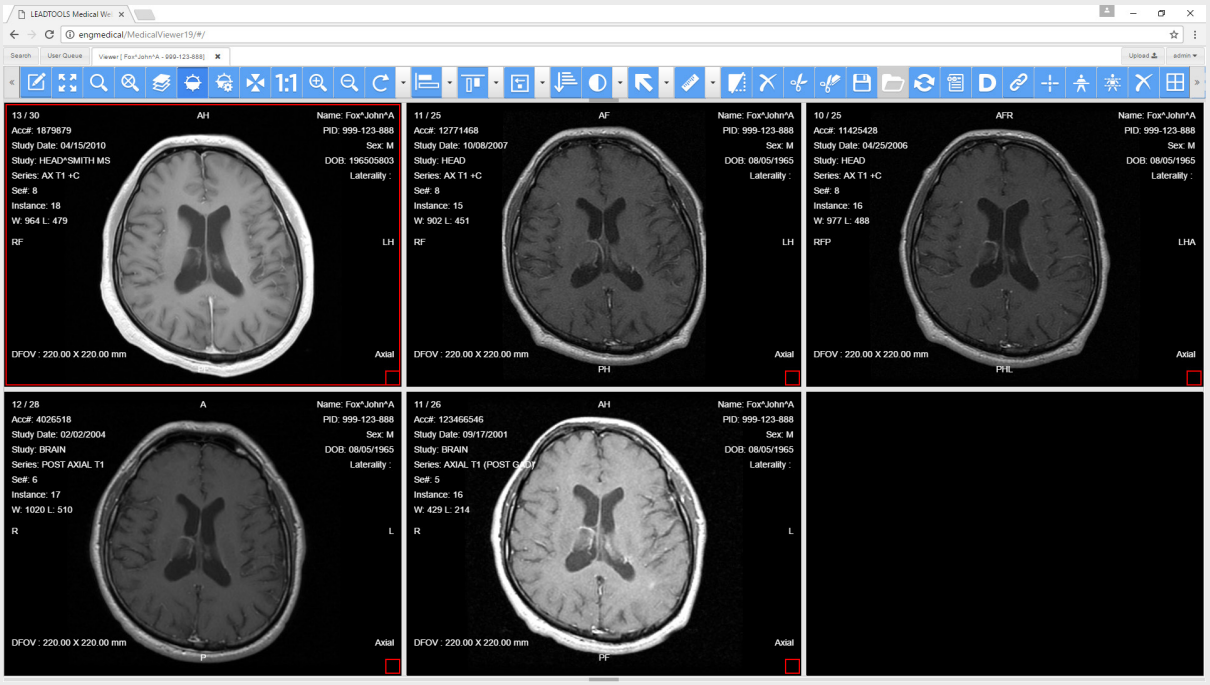

Figure 5: Using a Hanging Protocol with up to 5 priors for an MRI patient with many prior studies.

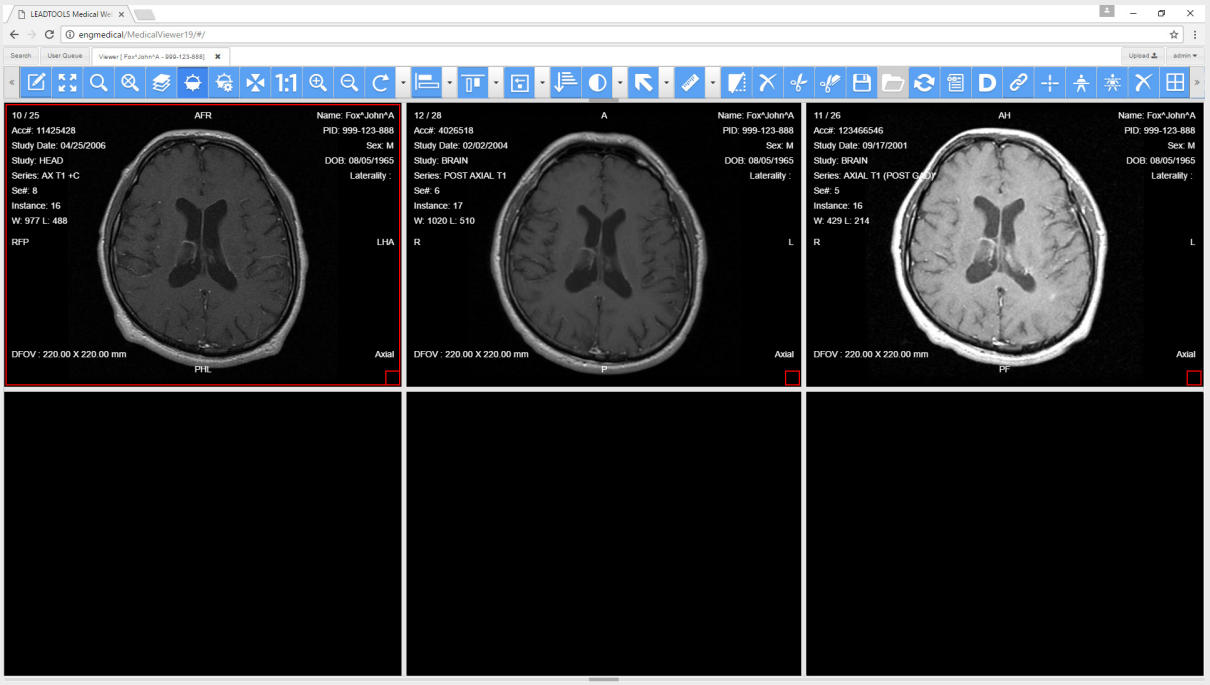

Figure 6: Same Hanging Protocol used on the same patient, but selecting an older "current" study. From that point in time, there are only 2 priors instead of 4.

Hanging Protocol Example 3: Side-by-Side Mammography Layout

Another medical discipline that can benefit greatly from DICOM Hanging protocols is mammography. These studies are very routine and for nearly every patient capture the same set of images. This means that doctors will similarly want to view these four images the same way every time.

However, sometimes images might need to be re-taken or are simply done out of order, so a traditional grid view for the series won't guarantee the correct placement. Additionally, most physicians have additional viewing preferences that stray from the industry standard of center-aligned images and wish to see the images justified and mirrored against each other.

1. Find any MG study with four images and load it into the viewer. The images are often placed into a single series, but it will also work if the study has four series with one image each.

2. Set the Study Layout to 2x2.

3. Click the Compose Layout button and drag the images into their appropriate cells. In the case of a 4-image series, you will actually be dragging the same series into each of the four cells.

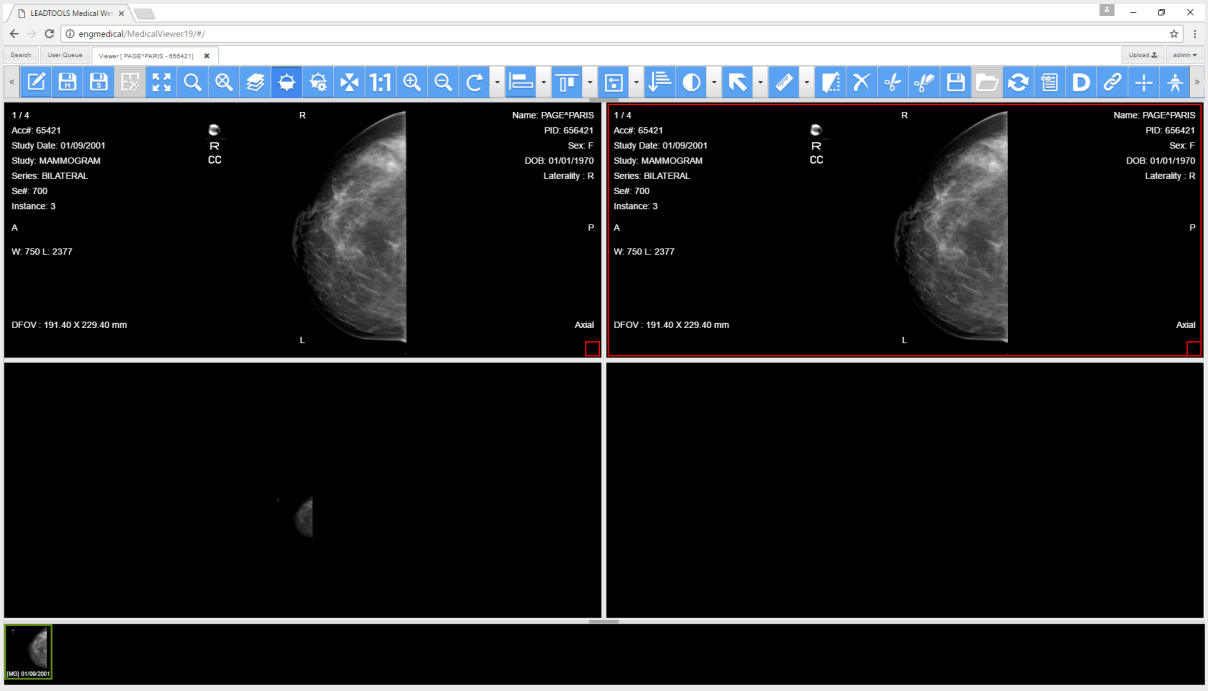

Figure 7: Composing the Hanging Protocol layout by clicking and dragging from the Study Timeline.

4. Scroll the images in each cell as desired so that the matching left and right images and view positions align with each other as if they were mirrored.

5. Now set the image justification to align the right cells to the left margin and vice versa, finalizing the mirrored layout.

6. Now we are ready to save the Hanging Protocol. Name it on step 1 and accept the defaults for step 2 to arrive at the Hanging Protocol Image Sets definition page. Some of these automatically detected selectors should be removed or edited, especially Image Laterality since it is currently only set to R. Deleting it will most likely be sufficient due to the nature of mammography captures, but we will set its value to "R\L" just to be safe in the unlikely event of an image captured from a different laterality.

7. The real magic happens for this layout on the final Display Sets page. Use the drop-down box to ensure that each corner of the layout is properly filtering by the desired View Position and Image Laterality. Without filtering these images strictly, duplicate images will appear, and each of the cells would be scrollable. Instead, the strict filtering restricts each cell to display only one image out of a possible 4 images in the series.

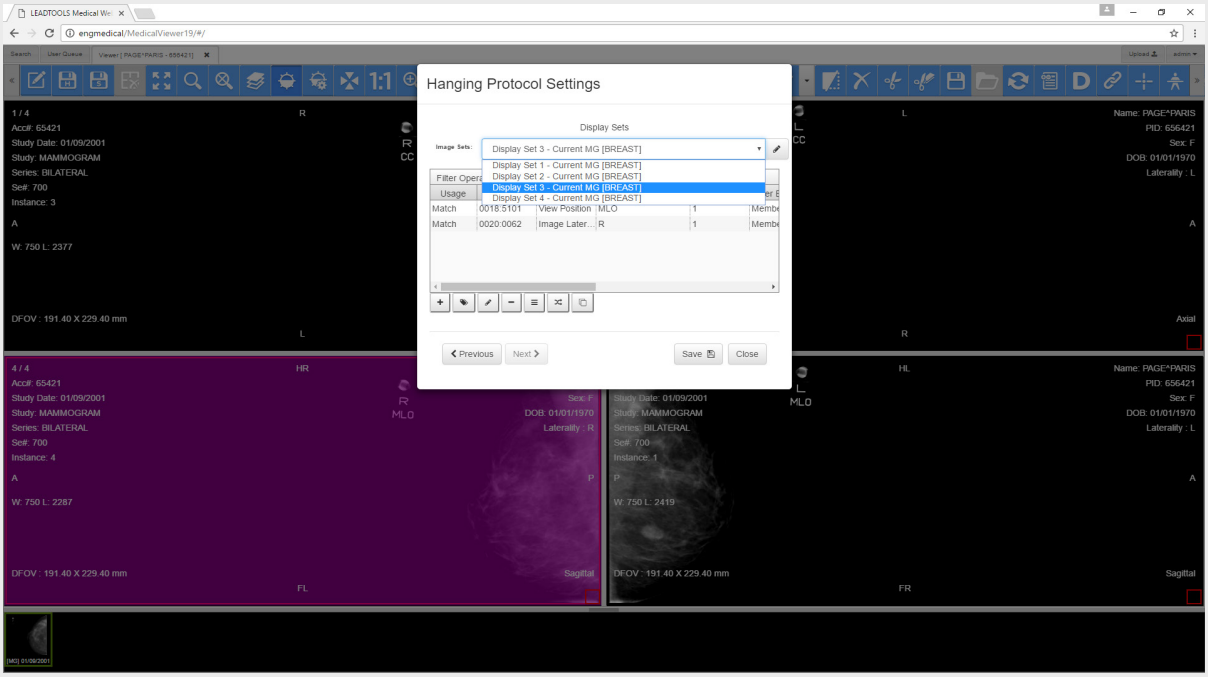

Figure 8: Defining the Display Sets (Step 4) with the Hanging Protocol Settings Dialog.

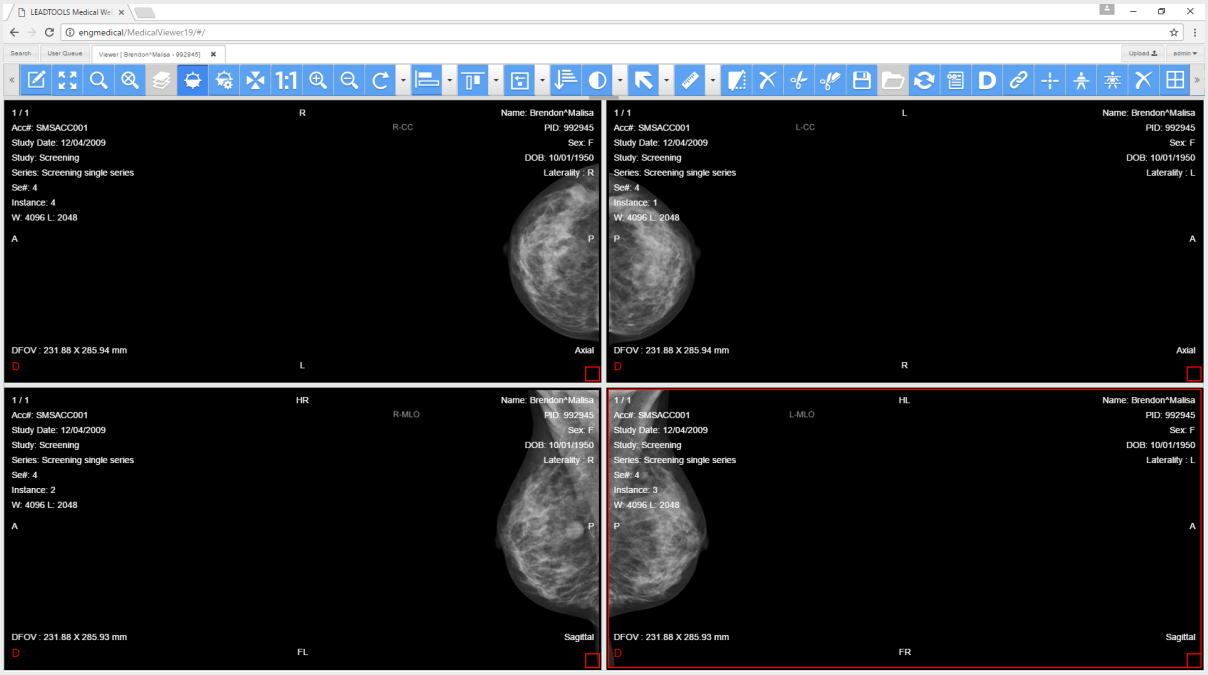

Figure 9: Using the new MG Hanging Protocol on another patient's images.

Hanging Protocol Example 4: Dental FMX

The dental market has some of the most specialized image layouts around. Due to the curvature of the mouth, many images are taken from various angles to give the dentists and hygienists the full picture on a 2D screen. A full mouth series of x-rays (FMX) does not follow the typical grid layout favored in radiology, but one that helps visualize and identify each tooth and their location in the mouth.

The LEADTOOLS Medical Web Viewer is also able to display images in a non-grid layout. Precise layouts can be drawn and then saved to the server for re-use. To make things even easier, LEADTOOLS already includes built-in and customizable templates for many popular layouts, including dental FMX 18 and FMX 20. Here are the steps for creating a dental FMX 18 hanging protocol:

1. Find a dental patient with an FMX 18 series and load it into the viewer.

2. Click the Study Layout button and select "FMX 18 Instance" from the templates drop down box.

3. You will now see the blank FMX 18 layout with non-grid cells.

4. Click Compose Layout to bring up the study timeline. Just as was done in the mammography study example, click and drag the same series into each cell, then scroll so that the correct instance is displayed in each cell.

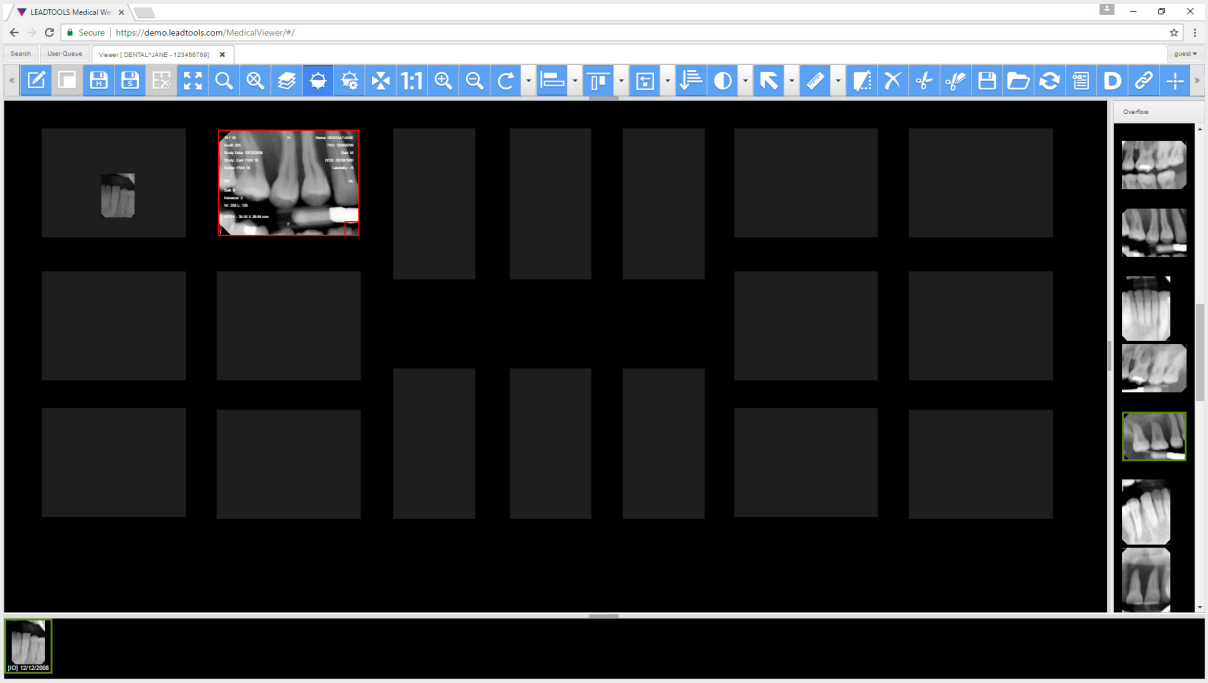

Figure 10: Dragging images from the study timeline into the non-grid FMX 18 Instance layout template.

5. Click on Save Hanging Protocol, give it a name, and proceed to step #3 on the Hanging Protocol Settings dialog.

6. Since we are setting up this Hanging Protocol for a specific device that will save the FMX 18 images in the same order, we can reliably trust that the Instance Number tag can be used to identify which image goes in each cell. Therefore, in step 3, delete the Study Description and Image Laterality tags and click Next.

7. On the Display Sets pane in step 4, delete the Image Laterality Tag from all display sets with the Delete Similar Filter Operations button. Click the Add Filter Operation button and use the dialogs to select and add Instance Number tag.

8. Click the Clone Filter Operation button, which will apply the selected filter operation (Instance Number in this case) to the remaining 17 display sets. This only clones the tag, and will check each cell's currently displayed image to get the value to apply in the filter operation, which will result in properly matched images when studies are loaded with this hanging protocol.

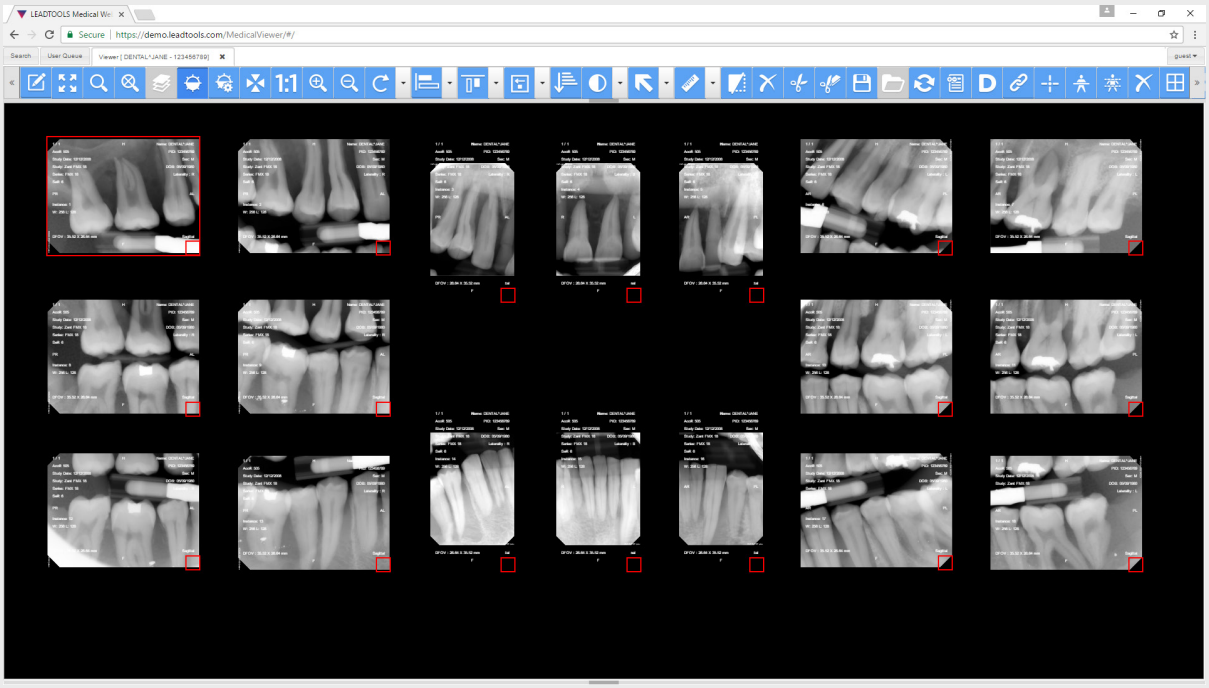

Figure 11: Applying the FMX 18 Instance to a study with a full set of FMX 18 dental images.

Conclusion

The long history of implementation difficulties, lagging supportive technology, and vendors not working together in an interoperable environment have dragged along the realization of true DICOM Hanging Protocol support. The market is ripe and demand is growing for this forgotten gem of the DICOM Specifications. Software developers keen on creating and integrating with VNAs can use medical imaging SDKs like LEADTOOLS to capture the market on both ends of the spectrum. Its HTML5 Zero-footprint Medical Viewer is a ready-built solution and can be a go-to viewer for any desktop or mobile platform and includes both DICOM Hanging Protocol support as well as all the other viewing tools medical professionals need. LEADTOOLS also includes all the DICOM communication and PACS support needed to easily build a VNA from the ground up or to create a central hub for integrating any existing third-party archive.

LEADTOOLS offers an incredible value with its comprehensive family of toolkits for medical, document, multimedia, and raster imaging. For more information on how LEAD Technologies can image-enable applications and boost ROI, visit www.leadtools.com to download a free evaluation, or give us a call at +1-704-332-5532.

Additional Information

Read more about LEADTOOLS DICOM Hanging Protocol SDK

Watch a video overview of the LEADTOOLS DICOM Hanging Protocol SDK

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About LEAD Technologies

With a rich history of over 26 years, LEAD has established itself as the world's leading provider of software development toolkits for document, medical, multimedia, raster, and vector imaging. LEAD's flagship product, LEADTOOLS, holds the top position in every major country throughout the world and boasts a healthy, diverse customer base and strong list of corporate partners including some of the largest and most influential organizations from around the globe.

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