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Integrating Molecular Imaging into Enterprise PACS

As more and more enterprises strive to go filmless by implementing enterprise-wide PACS, inevitably they find themselves in the situation where nuclear medicine and PET-CT become the biggest obstacles in achieving their goal.

The majority of PACS, including those from the major enterprise players, are designed to handle two-dimensional, static, grayscale images, such as images from conventional CT, MR, CR, and DR. Since these PACS' architectures and implementations, including software, hardware, and workflow, are optimized to handle this type of image, most PACS vendors are finding out that the core technologies that they developed to handle this type of image are now limiting factors in their ability to expand into the more complex modalities that require color, motion, and 3D/4D. These modalities include nuclear medicine, nuclear cardiology, PET-CT, SPECT-CT, multi-slice CT, general ultrasound, echocardiogram, vascular ultrasound, and cardiac cath.

To better understand the challenges faced by enterprise PACS to grow into molecular imaging, let's first look at the primary mission of an enterprise PACS.

The primary roles for PACS are image archiving, distribution, and image review. Workflow has also become a key part of PACS functionality these days. In an enterprise environment, secure and centralized image archive with effective disaster recovery capability, efficient enterprise-wide image distribution, and efficient workflow are key to the success of an enterprise PACS implementation.

With the rapid advances in computer technologies and the maturity of DICOM for general radiology modalities (CT, MR, CR and DR), the differences in archiving technologies among different vendors are insignificant. The image review technologies have also matured to the point that almost all major players offer similar features. So the main differentiators are now image distribution and workflow.

Over the years, many technologies were developed by various vendors to efficiently distribute images across enterprises. One such technology is Philips/Stentor's iSyntax technology, which greatly improves image distribution efficiency by transferring data only in the viewable area of the current image frame. Coupled with progressive streaming technology and proper frame buffering, image data seem to be instantaneously available over the enterprise network. Some other companies also employ similar technologies.

Although the above-mentioned technologies did wonders for images that are viewed frame by frame, they provide little advantage for molecular imaging modalities (nuclear medicine, nuclear cardiology, PET-CT, and SPECT-CT). The primary reason is that molecular imaging data are volumetric data. Not only you need to be able to view the

frames, but also you need to be able to reformat the data to provide views of different orientations. To do so, you need the complete set of volumetric data available for processing. Therefore, the frame-based image delivery systems are no longer useful without major modifications.

However, what really incapacitates conventional PACS when dealing with molecular images is not just the difference between 2-D or volumetric, but also the requirements for the following:

- The complexity of image types. There are 8 total image types in nuclear medicine. Each image type has its own unique requirements for presentation and diagnostic tools.
- The requirements for color presentations. Almost all molecular images require colors for presentation. Although these are pseudo colors, they are critical in presenting diagnostic information to physicians.
- Dynamic images. Many molecular images are dynamic, and they need to be presented accordingly.
- Image processing tools. One big difference between general radiology modalities and molecular imaging modalities is that molecular imaging requires much more extensive image processing. To fully support these modalities, many of these processing capabilities need to be made available in PACS.
- Quantitative analysis tools. This is the biggest difference between general radiology imaging and molecular imaging, especially nuclear medicine. In nuclear medicine, because of the low statistics, images alone normally do not provide sufficient diagnostic information. Diagnostic information is often derived from quantitative analysis of the images by using specially developed tools. These tools are often required on PACS for interpretation.
- Image fusion. Molecular imaging captures the function of the body, while CT captures the anatomy of the body. When these two types of images are combined, you will be able to see both function and anatomy simultaneously. Image fusion combines functional information with anatomical information in meaningful ways to clinicians.

Earlier we mentioned that there were no significant differences between vendors' archiving technologies for general radiology. Unfortunately this is no longer true for molecular imaging. Despite vendors' claims, users quickly find out that their molecular images are no long usable once they have gone through PACS. Although reasons vary, the primary cause is that key DICOM elements important to these modalities are mishandled, resulting in corruption or degradation of the data.

Now we see the major differences between general radiology and molecular imaging, as far as PACS are concerned, and understand why there is no quick fix for enterprise PACS to support molecular imaging. Does this mean we have to give up the idea of supporting these modalities, or do we have to throw away the existing PACS?

Many PACS vendors and users tried to use modality workstations to fill the void. Sooner or later they came to the realization that modality workstations are no replacement for PACS workstations. Why? The answer is workflow.

Modality workstations are result oriented. They are not too concerned with what it takes to get the result. PACS workstations, on the other hand, are driven by efficiency. For intended uses, modality workstations are generally designed for technologists, while PACS workstations are designed for physicians.

Although the majority of modern modality workstations support DICOM, that by itself does not make them PACS workstations, they appear on the PACS network as independent entities. Communications between these workstations and PACS are manual, even if they are manufactured by the same vendor. In other words, dataflow is not there.

But if that is all you have to work with, then having something is better than having nothing. Most people learned to cope with the inefficiency.

Are there better solutions? Let's see how Thinking Systems solves this.

Thinking Systems is a multimodality PACS vendor with unique strength in providing comprehensive PACS solutions for molecular imaging and cardiology. These solutions include PET-CT archiving and fusion, nuclear cardiology processing and quantitative analysis, general nuclear medicine processing and review, cardiac PET quantitative analysis, PET brain quantitative analysis, and solutions for echocardiogram, vascular ultrasound, general ultrasound, and cardiac cath. Besides providing complete PACS solutions scalable to any size, it also provides integration and plug-in solutions to existing enterprise PACS to support these specialty modalities.

Key to Thinking Systems' modality-PACS integration solution is its ModalityBroker™, which is the mediator between enterprise PACS and the modalities. As mentioned before, not all PACS understand the intricate details of molecular imaging modalities. As a result, vital modality information often becomes missing or corrupted in the process. To address this issue, the ModalityBroker™ puts a wrapper around the images to protect them. The appropriate applications would then unwrap them to retrieve the original data. On the flip side, these modalities often do not conform to the standards imposed by the PACS. One such example is that many PACS would not accept any study that has no accession number. But many molecular imaging scanners and workstations have no concept of accession number. So there is not even a place to enter such information. In such case, the ModalityBroker™ would bring the study into conformance by automatically fill in the accession number through HIS/RIS validation.

Molecular imaging is notorious for great variance in DICOM implementations. Communications between different vendors' systems are still major challenges, in spite of DICOM. The ModalityBroker™'s other duty is to be the "interpreter" of different "slang" of DICOM, so the enterprise PACS can communicate with the modalities.

Even though many large institutions have replaced their older scanners and modality workstations with newer ones, there are still many non-DICOM molecular imaging scanners and workstations out there. The ModalityBroker™ also has the capability to "speak" many "native languages" to communicate with these non-DICOM devices and convert proprietary images into DICOM images. Furthermore, if these non-DICOM devices "desire" to have images back in proprietary format, the ModalityBroker™ can also send the original data back to them.

Now the ModalityBroker™ has taken care of data communications between the enterprise PACS and modalities, the remaining areas to be addressed are clinical tools and workflow. These are accomplished through Thinking Systems' ThinkingNet™ plug-in.

The biggest difference between Thinking Systems plug-in and other vendors' is that while other vendors' plug-in only provides application functionality, Thinking Systems' provides both clinical solutions and workflow, powered by its multimodality PACS engine. The ThinkingNet™ plug-in not only provides PET-CT fusion, nuclear cardiology processing and quantitative analysis, general nuclear medicine processing and review, cardiac PET quantitative analysis, and PET brain quantitative analysis, but also provides auto pre-fetch, auto archive synchronization, multimodality comparison, and current-prior studies comparison.

Thinking Systems' ThinkingNet™ plug-in is currently integrated with Philips/Stentor's iSite PACS. The integration is smooth, seamless, and comprehensive. The plug-in's ActiveX based interface can also be used to integrate with other vendors' PACS.

In summary, molecular imaging poses the biggest challenges to enterprise PACS implementation, but solutions are available to overcome these challenges. Thinking Systems' proven PACS technologies for molecular imaging could be the missing link to complete filmless enterprise PACS implementation.