Acceptance Testing of Integrated Picture Archiving and Communications Systems

Thomas E. Lewis, Maria C. Horton, Thomas V. Kinsey, and Philip D. Shelton

An integrated picture archiving and communication system (PACS) is a large investment in both money and resources. With all of the components and systems contained in the PACS, a methodical set of protocols and procedures must be developed to test all aspects of the PACS within the short time allocated for contract compliance. For the Department of Defense (DoD), acceptance testing (AT) sets the protocols and procedures. Broken down into modules and test procedures that group like components and systems, the AT protocol maximizes the efficiency and thoroughness of testing all aspects of an integrated PACS. A standardized and methodical protocol reduces the probability of functionality or performance limitations being overlooked. The AT protocol allows complete PACS testing within the 30 days allocated by the digital imaging network (DIN)-PACS contract. AT shortcomings identified during the testing phase properly allows for resolution before complete acceptance of the system. This presentation will describe the evolution of the process, the components of the DoD AT protocol, the benefits of the AT process, and its significance to the successful implementation of a PACS.

This is a US government work. There are no restrictions on its use.

PICTURE ARCHIVING AND communication system (PACS) are growing in popularity throughout the healthcare industry. By definition, a PACS transmits and stores digital radiology images from local and remote locations for interpretation and diagnosis. Using PACS technology, there is the capability of creating a filmless environment that interacts with the facility on multiple levels. PACS are often integrated into the local area network (LAN) infrastructure, the hospital information system (HIS), and the radiology information system (RIS), if available. Although PACS technology is becoming less expensive, it remains a capital expenditure that at best reaches a break-even point at 36,900 studies per year using a 8.8-year equipment depreciation schedule.¹ Given the expense and the invasive nature of PACS, it is imperative that this type of multimillion dollar system once installed performs exceptionally well.

BACKGROUND

A method for validating the performance of PACS is through an acceptance testing (AT) process. Within the military, AT is the technical

evaluation that demonstrates contract compliance while serving as a payment milestone. To date, the Department of Defense (DoD) AT experience with military PACS has been with the Medical Diagnostic Imaging System (MDIS). In most cases, MDIS AT required multiple visits back to a site before the PACS was fully accepted for clinical use. As a result of these experiences, when the digital imaging network (DIN)-PACS contract was awarded, it included the unique requirement for mutually agreeable (between the government and the DIN-PACS vendors) AT protocols and procedures.²

Because DIN-PACS requires mutually agreed upon AT plans, the Joint Imaging Technology Project Office (JITPO) determined early on the need for a standardized AT protocol and approach for newly installed PACS systems that would save dollars and manpower. Although DIN-PACS has five configurations based on size,² this standardized AT plan provides a singular method for evaluating systems that are planned for interoperability. In addition, the standardized approach provides a consistent and comparative method of documenting vendor performance in functionality and performance.

THE PLAN

The AT plan was developed by a group of professionals with varied backgrounds. JITPO used professionals with backgrounds/disciplines in biomedical engineering, medical physics, radiology technicians, radiologists, communications and interface specialists to collaborate on the plan. The breadth of knowledge and varied backgrounds of

From the Joint Imaging Technology Project Office, Fort Detrick, MD.

The views and opinions expressed herein are solely those of the authors and should not be construed as official or reflecting those of the Department of Defense, Department of the Navy, Department of the Army or the Department of the Air Force.

Address reprint requests to Thomas E. Lewis, CW3, USA, Joint Imaging Technology Project Office, 1056 Patchel Rd, Fort Detrick, MD 21702-5012.

This is a US government work. There are no restrictions on its use.

0897-1889/99/1202-1049\$0.00/0

these individuals led to a portable and scaleable plan appropriate to all configurations.

CLINICAL USE DETERMINATION TESTING

Before the AT begins, a smaller subset of the actual team goes out and performs what is referred to as clinical use determination (CUD) tests. This idea was once again borne out of the experiences of the MDIS legacy system. In the past, a four- to six-person team was deployed sometimes thousands of miles across the globe and in at least 50% of the cases found out that the PACS was really not ready for AT. With CUD, one to two people go out as an advance party to insure that the system is ready for AT before deploying the entire team.

The CUD tests are made up primarily of "thread tests." These thread tests are designed such that mock patients are introduced into the HIS with imaging examinations that are normally performed within various locations throughout the hospital. The intent is to exercise the system (on a limited basis) as if it were a regular business day at the facility. By strategically running these threads, the advance team can determine relatively quickly whether the system is fully functioning or not. The idea is to test most of the major imaging acquisition devices to insure that images are successfully transferred into the PACS. Likewise, it is just as important to insure that the HIS is successfully integrating with the RIS so that patient folders, worklists, and prefetched images are being generated. Once the CUD is successful, then the rest of the AT team joins the advance team to complete the rest of the AT.

AT PROTOCOLS AND PROCEDURES

Full AT incorporates as much of the PACS system as possible. Once the formal AT begins, the intent is to push the system as hard as possible, while validating that the contract specifications are being met. Major areas evaluated include HIS/RIS interoperability, workstation software functionality, workstation monitor quality control, short-term and redundant array of inexpensive disks (RAID) storage capabilities, long-term archiving, image transfer performance, personal computer (PC) and web software functionality, teleradiology between facilities (when used), and finally Digital Imaging and Communications in Medicine (DICOM) functionality. DICOM includes not only the PACS itself, but also all associated imaging modalities.

The HIS/RIS interoperability is critical to ease of use and time saved when using a PACS. This part of the system was already partially tested at CUD, but this time, the system will be stressed even harder by entering multiple examination orders simultaneously. As many of the acquisition devices as possible will be in operation to where multiple images are being entered into the PACS system. Areas of concern here include whether or not radiology examination information entered into the HIS migrates into the RIS. An additional critical link involves modality worklists and the capability of properly linking reports and exams.

The workstations used within DIN-PACS are also a major element that needs testing. With AT, "all" of the radiologist's 2K workstations and a percentage of the clinical 1K review workstations are tested. With the monitors, areas such as contrast, brightness, brightness uniformity, linear distortion, and spatial resolution are some of the main areas that are verified. Also, most of the software parameters are checked to insure that each of the workstations operates correctly. Some of the more important software features that are validated include image display protocols and manipulation, image interrogation functionality, reports functionality, worklist management, and worklist navigation tools.

A critical area concerning workstation performance includes image display speed. The DIN-PACS contract is very specific regarding this area. For example, computed radiology examinations are to have the full image displayed on the first monitor from the RAID within 2.5 seconds. For computed tomography, magnetic resonance imaging, ultrasound, and nuclear medicine, these images are to be displayed within 2.5 seconds for the first monitor and 2.5 seconds for each subsequent monitor, with all four monitors filled within 10 seconds coming off of the RAID.² Although not always an easy task, this type of test would be performed when the local area network activity is at its peak. It is critical that this type of image retrieval performance can be achieved during those peak use hours of the day since it is at this time that the LAN will be used to its maximum capabilities.

DICOM functionality is another critical portion that is evaluated during AT. JITPO is currently using a software tool that will help in the evaluation of this important task. Once the PACS is installed, the goal is to have "all" of the acquisition devices

integrated with the PACS. If this is the case, then thread tests can be used to determine if images from those modalities are successfully transferred to the PACS. If the modalities are not yet installed or integrated with the PACS, then by using this tool, the JITPO can set up mock tests where a laptop computer is used to mimic any/all types of acquisition modalities as a DICOM storage class user (SCU).

SUMMARY

In conclusion, AT is a critical component to the successful implementation of PACS. Nonvalidation of any part affects hospital functionality and poten-

tially increases organizational costs during the maintenance phase. It is because of this hospital-wide functionality that the user has the right to verify whether or not the vendor has delivered the product as expected. Thorough up-front testing can insure that problems are identified and corrected prior to becoming a clinical or legal burden. This type of AT testing will provide a benefit to any organization making the capital outlay for PACS.

REFERENCES

1. Hayes J: High volume radiology departments save \$12 per exam with PACS. *Telehealth* 4:15-18, 1998
2. DIN-PACS Contract, SP0200-98-D8701. Defense Supply Center, Philadelphia, PA, November 20, 1997