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DICOM Configuration Management using Configuration Cockpit Tool

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Abstract—Tele-radiology is one of the most evolved areas of telemedicine [1]. The management of network and information services in a hospital environment is an arduous task with continuous new challenges. DICOM (Digital Imaging and Communications in Medicine) makes medical image exchange more easy and independent of the imaging equipment manufacturer. Besides the image data, DICOM file format supports other information useful to describe the image. This makes DICOM easy to use and the data exchange fast and safe while avoiding possible confusion caused by multiple files for the same study [2]. DICOM standard is primarily used in diagnostic medical imaging, especially in radiology, cardiac disciplines and other related disciplines; it can still be widely used in clinical and other medical statements of strictly declarative images and non-image related information [3]. The DICOM evolved as a standard for handling, storing, printing and transmitting information in medical imaging. The mechanism presented in this paper allows the smooth installation of the DICOM network configurations through a tool called DICOM Configuration Cockpit. The DICOM Configuration Cockpit is a tool designed to improve the communication process during installation of new Cath labs. A FSE (Field service engineer) can use this application along with the Hospital IT team to gather the hospital network parameters that are an essential part of the installation process. This tool aims to provide smooth flow of Network and DICOM related information between the Service Engineer and the Hospital Administrator. Currently DICOM assumes that only a manageable number of devices is used on a network and it currently requires every device to have a static IP address. At present, an engineer entering the information into each machine independently configures each manually.

Keywords—DICOM, PACS, TCP/IP.

I. INTRODUCTION

Medical imaging and related information systems are vital for modern medical care services and medical research. Therefore, the intercommunication of digital image information between devices of different manufacturers is critical. Digital Imaging and Communications in Medicine (DICOM) [4] [5] came forth as a standard for managing, transmitting information in medical imaging, searching, distribution, viewing, printing, archival and storage. DICOM standard facilitates interoperability of medical imaging equipment by specifying the following - a set of media storage services, network communications protocols, the syntax and semantics of the exchanged information. The communication protocol also known as application protocol is used to

communicate between systems using TCP/IP standards. DICOM is the main protocol used to transmit images from multiple source medical imaging device types into a Picture Archiving and Communication System (PACS) [7]. PACS provide the storage and easy access to medical images from many sources.

DICOM enables the integration of medical imaging devices like scanners, workstations, servers, printers, PACS and network hardware from multiple manufacturers.

DICOM encodes the data produced by a wide variety of imaging devices including CT (computed tomography), MRI (magnetic resonance imaging), Ultrasound, X-ray, Angiography etc. DICOM is also implemented by devices associated with images or imaging workflow including PACS, Image viewers and display stations, CAD, 3D visualization systems, Clinical analysis applications, Image printers, RIS (radiology information systems), Film scanners, Media burners, Media importers (that import DICOM files from CDs, DVDs, USBs, etc.) and EMR (electronic medical record) systems [6].

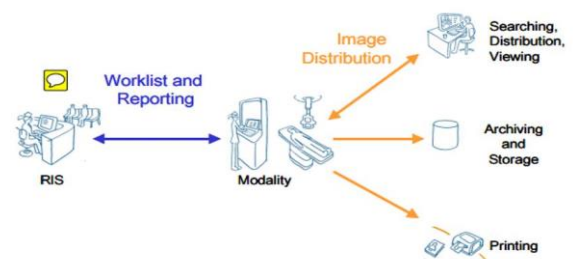


Fig. 1. DICOM standard used for communication

DICOM makes medical image exchange more easy and independent of the imaging equipment manufacturer. Besides the image data, DICOM file format supports other information useful to describe the image. This makes DICOM easy to use and the data exchange fast and safe while avoiding possible confusion caused by multiple files for the same study.

DICOM and DICOM Configuration Management are very different compared to these concepts. DICOM does not consider device states and instead is a message based protocol, which means requests (example: please send me this image) and responses (example: here binary image data) are exchanged between devices. Configuration Management describes device and network configuration parameters [8].

Hospital network / IT parameters are often not available on time for the DICOM Configuration Set-up. Negative effects on installation are:

- Time loss to get information- up to 1 day.
- Rework or duplicate work for workarounds (Extra labor and travel cost to fix it later).
- Risk in missing scheduled installation end date, unprofessional impression on customer.

The Hospital Administrator also needs specific security related information about our systems, to be able to prepare the hospital network. Systems from other companies (PACS, RIS) must be prepared beforehand; otherwise, the connection with the new system is not possible.

This is due to lack of technical interaction with customer to communicate about connectivity/networking requirements, no information on system Configuration at the hospital, not providing specific information that customer needs (about our system) to prepare network. To have a professional discussion with the customer some preparation is needed. Sometimes it is not so easy to find all this information. The result is an unprofessional phone call or e-mail to somebody who may or may not have this information.

II. SYSTEM DESCRIPTION

The Configuration Cockpit is a set of tools aimed at smooth flow of Network and DICOM related information between the Service Engineer and the Hospital Administrator. The tool helps the Installation Manager / FSE in collecting the necessary data prior to the installation. The tool also provides information that can be shared with the Hospital IT personnel towards understanding the requirements for making the hospital network and other third party systems ready for the installation. The entire workflow for collecting the information is divided into 3 steps:

- Generating a custom Network Sheet based upon Hospitals Order.
- Collecting Network and DICOM information from Hospital Administrator.
- Generating guiding instructions for FSE and Requests for Hospital Administrator.

Program manager prepares network connectivity sheet that is specific for the customers solution using standard Network Connectivity Tool before installation. The tool is standardized in such a way that it makes it easy for the customer to provide the required information. The installer for network and Configuration work uses the output (filled in connectivity sheet). Waiting time at installation eliminated and FSE labor is reduced by transferring internal network.

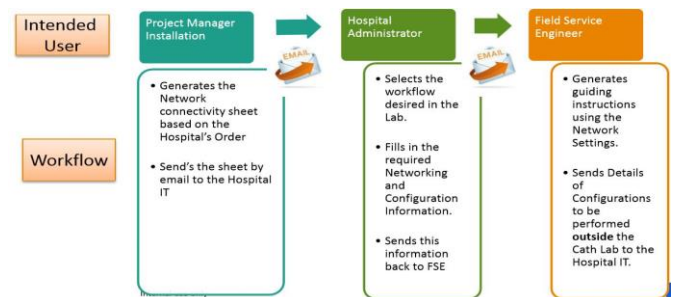


Fig. 2. Complete workflow of installation process

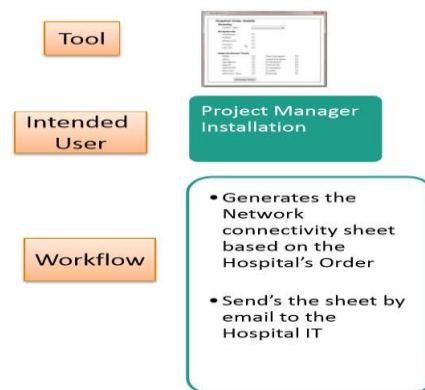


Fig. 3. DICOM Sheet Generation

III METHODOLOGY

The DICOM configuration Tool is designed using Visual Studio C Sharp. The interface will allow the user to select Modality System like Allura and Azurion, peripheral devices (Viewforum, Xcelera, Ultrasound, Xper Flex Cardio, Philips Hemodynamic, Other) and interventional devices (Interventional Workspot, Echo Navigator, Coronary Tools) that the hospital requires from the Order Sheet. Once the device selection is done, a HTML sheet (form) or Network Sheet is generated which will have provisions for information regarding IP, Hostname, MAC address, AE (Application Entity) Title [9], Port number, Subnet mask[10], Default Gateway etc. for the devices selected. Hostname is the hostname of the PC connected to

the hospital network. MAC Address is the MAC Address of the PC connected to the hospital network. AE Title is used for DICOM communication with PACS and DICOM printers. Port number is the port used for DICOM communication.

Once the form is filled, a text file with the details can be generated. This file can be loaded into the DICOM tool and instructions for FSE, Hospital IT can obtain the data entered into the form.

Currently DICOM assumes that only a manageable number of devices is used on a network and it currently requires every device to have a static IP address. At present, an engineer entering the information into each machine independently configures each manually [13]. Provision is made for the following:

The software tool can be installed and runs on a Windows 7/ Windows10 based system [11]. The tool shall provide basic validation for the syntax of the configuration attributes, such as MAC address [12], IP Address and a check for duplicate values. The tool shall provide the details of the systems, such as operating system details, security aspects and information required by the hospital IT. The tool makes it possible to share the network sheet generated with the hospital administrator, via email or in printed form. The tool makes it possible to load the information saved in the text file, and edit the network sheet for adding more details or modifying the values already entered. The tool shall provide instructions for the Hospital IT for configuring the other devices in the hospital such as PACS, Printers, and Time Servers.

The tool shall provide detailed instructions for the FSE / Installation team on configuring the system with the networking and DICOM settings.

The tool shall provide an option for entering additional information, such as special instructions that the FSE has to follow or information that might be incomplete and needs to be verified etc. Only authorized personnel having IST authorization shall use the tool. The tool shall provide an option to provide feedback regarding the tool. The tool shall provide detailed help information on usage of the tools. The tool shall provide the remote connection option to be selected from the Order Sheet

III. RESULT

The Configuration Cockpit tool is used by every FSE on each Cath lab. It will result in time saving of up to 7 hours (integrally pre-installation and installation work).

Earlier time spent 14 hours (FSE 1 hour before installation, 13 hours during installation, including waiting time) Current time spent 7 hours (2 hours FSE before installation, 2.5 hours FSE during installation, 2.5 hours FFI during installation.) Saving 7 hours (1 day of work) of FSE time per Cath lab equals 14000 hours of work saved. An FSE works 40 hours a week, 2080 hours per annum. This translates to more than 6 years worth of time saved.

An average FSE earns \$65,000 per annum. Saving 6 years worth of pay of a single engineer in the first 2 months of using this software alone translates to \$400,000. The revenue savings over the lifetime of the Allura/Azurion system, which is expected to be over a decade, is in millions of dollars. Hence, by using DICOM Configuration cockpit tool, the installation process is made smooth and time conservative.

IV. FUTURE WORK

As listed above currently the machines are manually assigned IP addresses, but another better approach is to use Dynamic Host Configuration Management Protocol for automatically assigning IP address to the machine. However, one DHCP server must exist on a network so DHCP server software is installed; you create a DHCP scope, which is a pool of IP addresses that the server manages. When clients log on, they request an IP address from the server, and the server provides an IP address from its pool of available addresses [13]. The Dynamic Host Configuration Protocol (DHCP)[14], which automates the configuration of computers that use TCP/IP. DHCP can be used to automatically assign IP addresses, deliver TCP/IP configuration parameters (such as the subnet mask and default router) and provide other configuration information such as the addresses of timeservers [15].

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