

# **Reliable Images: the DICOM Standard for Medical Imaging**

## **Background**

Medical images are an essential tool for providing high quality medical care. In the 1970s, the electronics industry introduced digital medical image services and hospitals began using computers to process the images. Multiple imaging technologies have emerged including computed radiography, computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine, and ultrasound.

Initially, most devices stored images in a propriety format and transferred these files over an internal network or on removable media. These incompatible systems made images inconsistent and sharing information across different manufacturers' equipment very difficult, expensive, and unreliable. . As hospitals expanded their use of networks, this incompatibility became highly inefficient.

## **Problem Statement**

In order for physicians, hospitals, and patients to fully reap the benefits from digital medical images and information, all communication of this information must be compatible. When manufacturers use proprietary formats, the digital files can be read only with that manufacturer's equipment and/or software. Communicating these files over multiple networks and the Internet presented additional problems. As digital medical information evolved, the medical community demanded interoperability and a standard method for transmitting medical images and their associated information.

## **Approach**

Starting in 1983, the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) formed a joint committee to create a standard method for transmitting medical images and their associated information. In 1985, this committee published the ACR-NEMA Standards Publication No. 300-1985 which created standardized terminology and a structure for information exchange.

The committee continued to update the standard, and in 1988, they published ACR-NEMA 300-1988 (considered version 2.0). Computer network standards developed rapidly allowing the ACR-NEMA Standards Committee to develop the network-based standard (version 3.0) in 1993. To reflect the standard's broader scope and evolution, they changed the name to Digital Imaging and Communications in Medicine (DICOM). This was a multipart standard formally called ACR/NEMA Standards Publication No. PS 3.X, where X designated the specific part – e.g., Part 3: Information Object Definitions.

DICOM is an independent, international standards development organization administered by NEMA's Medical Imaging and Technology Alliance. The DICOM standard's executive body is the DICOM Standards Committee (DSC). DSC's 50 members include imaging equipment manufacturers, physician organizations, user organizations, government agencies, and trade associations. The DSC has two cochairs, one representing equipment producers and the other representing the user community. Working groups perform most of the work on extensions and corrections for the standard.

The working groups may receive work items from the DSC or may propose them based on their members' suggestions. The product of a work item, generally a supplement or correction, goes through a review and approval process. Once approved, the changes become an official part of the DICOM standard. The current version of the Standard consists of the last published compilation plus all of the supplements and change items that subsequently have been approved. For convenience of users, the compiled version is updated about once each year.

The DICOM standard currently consists of 18 parts in a document that numbers over 4100 pages. To assure that everyone who needs the DICOM Standard has access to it, the Standard is available for free at <ftp://medical.nema.org/medical/dicom/2009/>. At any given time there may be as many as 30 additional supplements and 80 - 100 change items under development. Some parts apply almost exclusively to network transfer; others apply to interchangeable media. DICOM includes standards not only for images but also for patient records, studies, reports, and other data groupings.

DICOM standardization has contributed to improvements in image quality. To achieve consistency of image presentation on film and on different display monitors – regardless of the brand, type, and characteristics of the media – required a “gold standard” for all monitors and hard-copy devices. The standard needs to specify the exact luminance or density level produced for a certain input value. DICOM chose to map values into a perceptually linear range, that is, one that a human observer would perceive as a line. As a result, the images look alike. When a radiologist sends an image to a physician, both see the same grayscale presentation. The same applies for the technician who wants to ensure that a monitor image and the film image are the same. The DICOM Grayscale Display Function Standard achieves this consistency.

The DICOM Presentation State Storage Service Class ensures presentation consistency. A physician interpreting an image may adjust magnification, window width, and window center or apply various image processing enhancements. DICOM stores the information about these changes so that, at a later time, a user can display the original images.

DICOM continuously updates the standard, producing approximately 10 major additions and 100 correction items per year. The vigilance and international participation of professionals throughout the radiological, medical, and imaging technology fields guarantees that the standard will expand along with technology and usage. DICOM is already part of major initiatives such as Integrating the Healthcare Enterprise (IHE). As patient information transfers to digital forms, all Electronic Health Record (EHR) systems that include imaging information as part of the patient record will require DICOM.

### **Outcome**

The DICOM standard not only permits the transfer of medical images in a multi-vendor environment. It also provides a strong base for developing and expanding picture archiving and communication systems, and it supports interfacing with medical information systems. DICOM has a key role in virtually every medical profession that

uses images, including cardiology, dentistry, endoscopy, mammography, ophthalmology, orthopedics, pathology, pediatrics, radiation therapy, radiology, and surgery as well as veterinary medical imaging.

DICOM supports the process of integrating information produced by these various specialty applications to produce the patient's Electronic Health Record (EHR). DICOM also defines the network and media interchange services allowing consistency so that EHR records are available to all who need them. The worldwide ambition in the healthcare industry to create EHRs for every patient guarantees the use of DICOM objects and services in commonly used information technology applications will continue to grow.

Ultimately, the benefit falls to the patient. Physicians have better access to images and reports allowing them to make a faster diagnosis, potentially from anywhere in the world. As a result, patients can potentially obtain faster, more effective care.