Digital Imaging and Communications in Medicine in 1997: An Update

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THE AMERICAN College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) began in 1984 to develop a standard interface for medical imaging equipment. This standard was to provide output of images in digital form along with information necessary for the interpretation of the images. From the original point-to-point specification published in 1985¹ to the fully networked Digital Imaging and Communications in Medicine (DICOM) standard of today,² the standard has proven to be a valuable asset for medical imaging.

The DICOM standard is complex out of necessity. Much as legal language tends to be difficult for the uninitiated to understand, the language of standards is driven by a need to be unambiguous with the unfortunate result of not being very readable. DICOM also contains concepts that may not be familiar to most radiologists or other specialists in medical imaging who need to specify the standard in the products that they purchase.

The fundamental basis for DICOM is the information model. This model describes both the "things" involved in medical imaging (eg, the patient, the image, and the report) and how those things are related. A technique for developing such models is called object-oriented analysis for its method of determining the things (or objects), their characteristics (or attributes), the relationships between objects, and what functions they perform or have performed on them. The method has proven of great value to many information-rich enterprises as the modeling process forces a thorough analysis of the system being modeled. The value of this model to DICOM is that it is unambiguous and may be added to as new situations require.

The DICOM information model translates directly into the information objects used in the standard. These are the things such as those noted above; patient, image, and report as examples. The attributes that describe these objects are the "elements" in the DICOM data dictionary (patient name as an attribute of the patient object, eg). The importance of the information object for communi-

cation is that the devices communicating have the same definition of what it is they are trying to communicate.

In a picture archiving and communication system (PACS), simply moving information around is certainly not sufficient to make the system work. Operations have to be done on, or using, the information for a system to be useful; the actual display of a computed tomography (CT) image of the chest, eg. DICOM also describes a set of services that devices can use to perform functions with the information objects. DICOM helps devices know what information they have and what they are to do with it. The combination of a service with an object is the fundamental functional unit of DICOM. This combination is called a service object pair, or SOP, and the terminology will be found throughout the standard.

DICOM is a communications standard, so besides describing the objects being communicated and what devices are to do with the information they get, it specifies things needed for successful communication. At a very low level, this involves referencing an existing standard for the network to be used. At a somewhat higher level, the standard specifies how two devices expect the information to be coded electronically. Near the top of the levels that DICOM specifies is the ability for two devices to negotiate so that each knows what the other is capable of doing.

A standard is of little use if it is not adhered to. DICOM provides a method for manufacturers to claim conformance in a meaningful way. A conformance statement is required of any vendor claiming to be DICOM conformant. The structure of this statement is itself standardized so that all conform-

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ance statements must have the same structure (though the content will, of necessity, differ depending on what the device claims to do).

The aim of the tutorial is to explain these concepts in more detail with a goal of “demystify-

ing” the DICOM standard. There is no doubt that the learning curve for DICOM is steep, but with a better understanding of the basics, the consumer of products using the standard will know both the strengths and limitations of the standard.

REFERENCES

1. National Electrical Manufacturers Association: Digital Imaging and Communications in Medicine; ACR-NEMA 300-1985. Washington, DC, NEMA, 1985

2. National Electrical Manufacturers Association: Digital Imaging and Communications in Medicine (DICOM); PS3.1-PS3.13. Washington, DC, NEMA, 1993-1996