THE DICOM 2014 Chengdu Workshop

August 25 Chengdu, China

DICOM℠
Digital Imaging and Communications in Medicine

DICOM Overview: Stability and Evolution

Kevin O'Donnell

Toshiba Medical Research Institute - USA, Inc.

Sr. R&D Manager

Past Chair, DICOM Standards Cmte

Member, WG6, WG10, WG12, WG21, WG29

TOSHIBA
Leading Innovation

DICOM: A Family of Protocols

DICOM℠
Digital Imaging and Communications in Medicine

Protocol

- Specifies how two systems exchange information

Many kinds of Systems:

- Modalities, PACS, RIS, Workstations, EMR,…

Many kinds of Information:

- Images, worklists, measurements, surfaces, audit logs, …

Routine Clinical Practice

DICOM
Digital Imaging and Communications in Medicine

Scheduling Exams

Distributing Images

Acquiring Images

Medical Imaging

Reporting Images

Managing Images

Displaying Images

Processing Images

Store Images

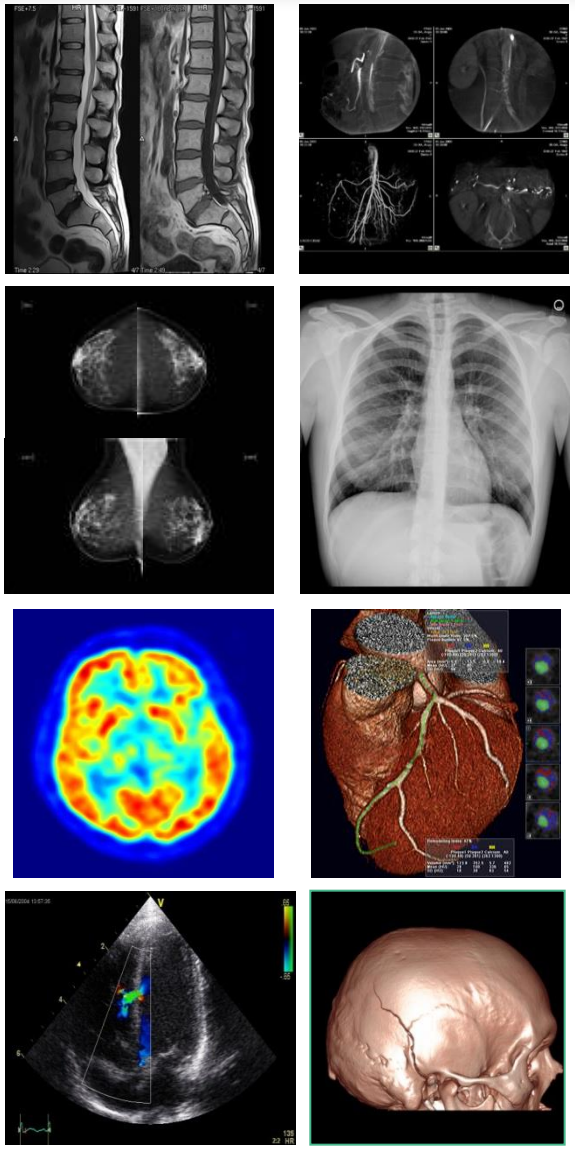
DICOM℠
Digital Imaging and Communications in Medicine

DICOM stores your images

- All kinds of images
- CT, MR, X-Ray, Ultrasound, Angiography, PET, … Ophthalmology, Scanned Documents
- Single & Multiframe; Volumes & Cines; B&W & Color; Original & Processed

DICOM helps manage your Images

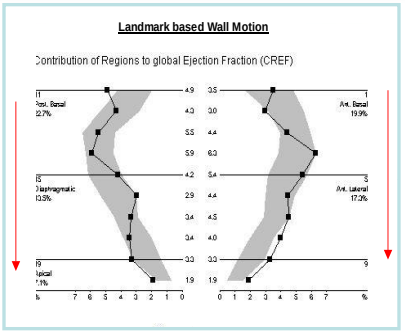
- Not just pixels; Significant meta-data
- Patient identification & demographics, the order, eqt, acquisition, workflow context, …
- PACS = database; DICOM = machine readable
- Can query/sort/autoroute/manage

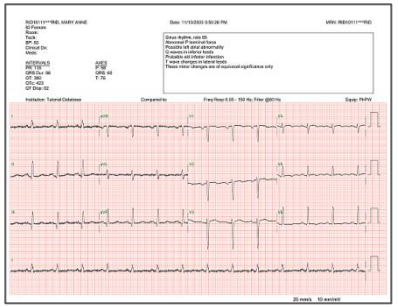


Other DICOM Components

Store (Imaging) Data

- fetal growth, cardiac output, tumor size, CAD findings, ECG Waveforms



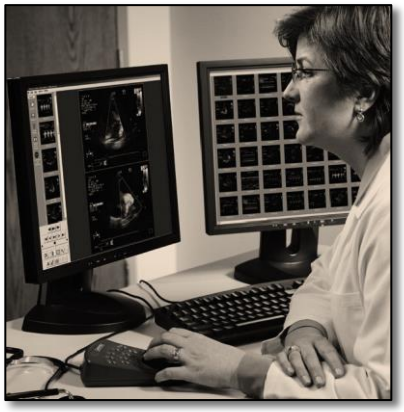


Manage (Imaging) Workflow

- Modality Worklists, Progress updates, Storage Commitment

Display Images

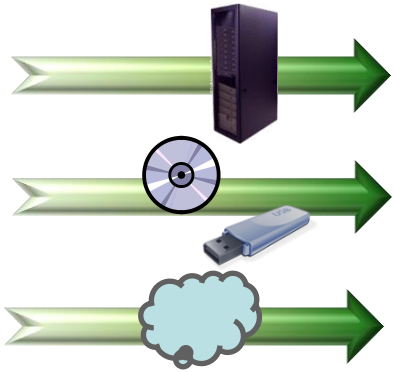
- Screen calibration, annotations, layouts, key image flagging



Other DICOM Components

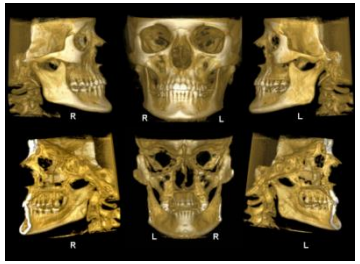
Distribute Images

- Network push/pull,
  Media Transfer (CD, USB, Bluray…),
  Email Attachments,
  Web Protocols



Store Analysis Results

- Registrations, Segmentations, Implant Models

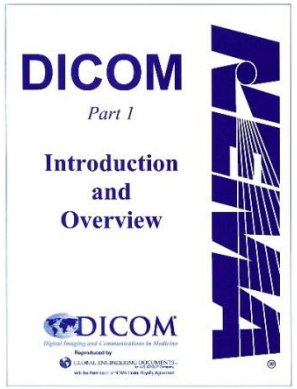


Security

- Audit Trails, De-identification Schemes, Encryption

DICOM is not Static

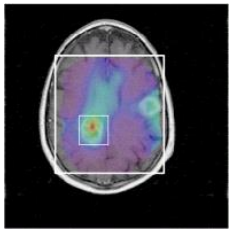
DICOM
Digital Imaging and Communications in Medicine

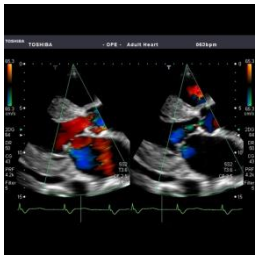


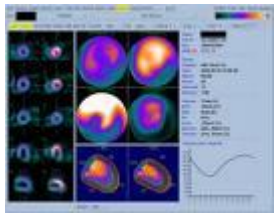
DICOM first published in 1993

Extended regularly to meet the expanding needs of Medical Imaging:

- Multi-slice CT
- 3D Ultrasound
- Web-based PACS
- USB Memory Sticks
- Clinical Measurements
- Radiation Dose Reporting
- Image Registration & Segmentation
- Computer Aided Detection/Diagnosis
- and Many, Many More . . .







DICOM Change Process

Supplements for major changes

- New object types, new services, new compression schemes
- About 10 / year
- Developed by Working Groups
- Require Work Item approved by DICOM Standards Committee

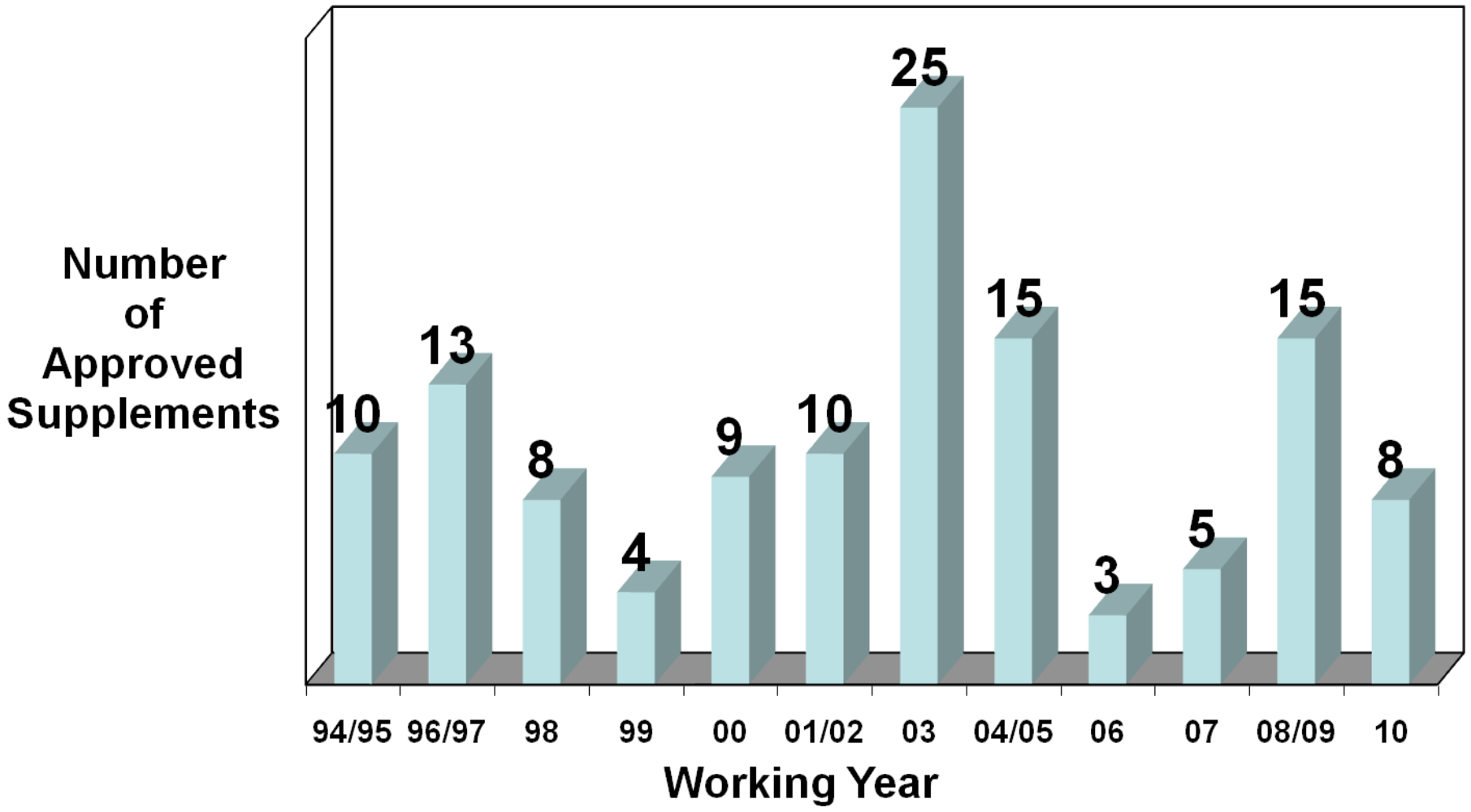
Change Proposals for minor corrections

- About 100 / year
- Anybody can submit
- Backward Compatibility: Avoid changes that break existing implementations

Consolidated edition published every year (or so)

- Most recently, Late 2011
- Available free at DICOM web site
- Vendors responsible for monitoring final text changes

DICOM Supplements



Working Groups

DICOM
Digital Imaging and Communications in Medicine

Modality, clinical domain, or function specific teams, assigned to develop Supplements or Change Proposals

WG-01: Cardiac and Vascular Information
WG-02: Projection Radiography/Angiography
WG-03: Nuclear Medicine
WG-04: Compression
WG-05: Exchange Media
WG-06: Base Standard
WG-07: Radiotherapy
WG-08: Structured Reporting
WG-09: Ophthalmology
WG-10: Strategic Advisory
WG-11: Display Function Standard
WG-12: Ultrasound
WG-13: Visible Light
WG-14: Security
WG-15: Digital Mammography and CAD
WG-16: Magnetic Resonance
WG-17: 3D
WG-18: Clinical Trials and Education
WG-19: Dermatology
WG-20: Integration of Imaging and Info Systems
WG-21: Computed Tomography
WG-22: Dentistry
WG-23: Application Hosting
WG-24: Surgery
WG-25: Veterinary Medicine
WG-26: Pathology
WG-27: Web Technology for DICOM
WG-28: Physics
WG-29: Education, Communication & Outreach
WG-30: Small Animal Imaging

Maintaining Stability

DICOM
Digital Imaging and Communications in Medicine

Extension, not "Versioning"

DICOM is a family of SOP Classes

- It's just "DICOM"; Not DICOM 3.1, 3.2, 3.3, etc.
- Conformance is to SOP Classes;
  Not to a 'version' of the Standard
- New SOP Classes are added;
  Old SOP Classes don't change
- Most applications continue to support older SOP Classes when supporting new ones

DICOM SOP Class

Service + Object = Service Object Pair
(Storage + MR Image = MR Image Storage)

MR Image Storage SOP Class

SCU

SCP

SCP – Service Class Provider

- **the system that provides the service**

SCU – Service Class User

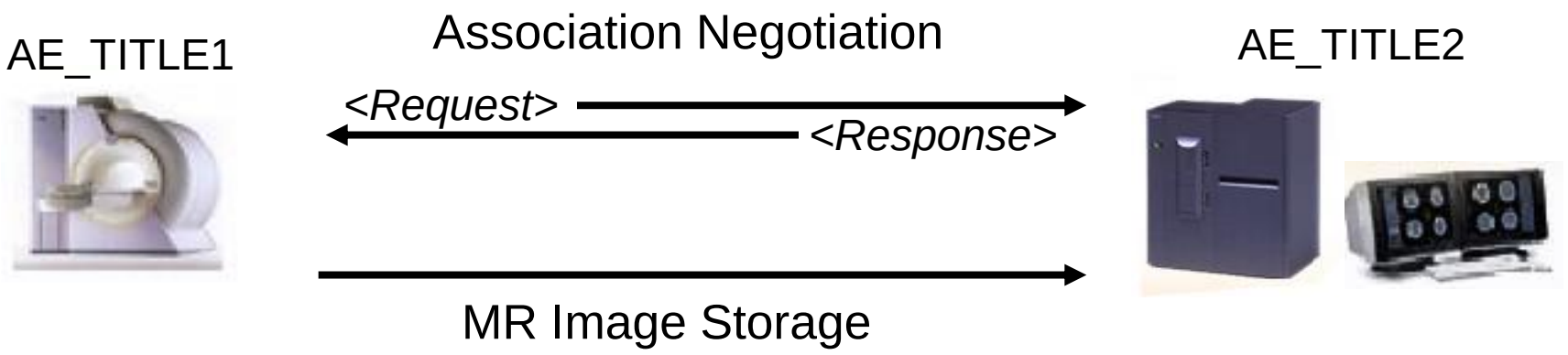
- **the system that uses the service**

DICOM Association Negotiation

Before two Application Entities (AE) perform a DICOM transaction they first agree:

- **what SOP Class they will use (e.g. MR Image Storage)**
- **who will be the SCU, who will be the SCP**
- **what the Transfer Syntax will be (e.g. JPEG Lossless)**

This process is called Association Negotiation

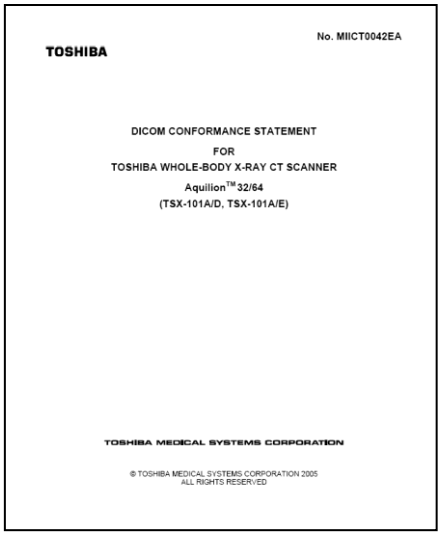


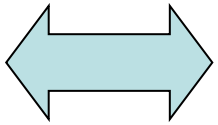
Product DCS

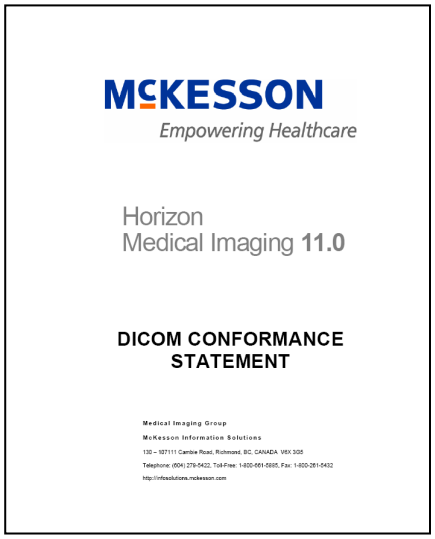
DICOM Conformance Statement

- lists the SOPs supported by a product
- describes product implementation details and behaviors

(See DICOM Part 2: Conformance)

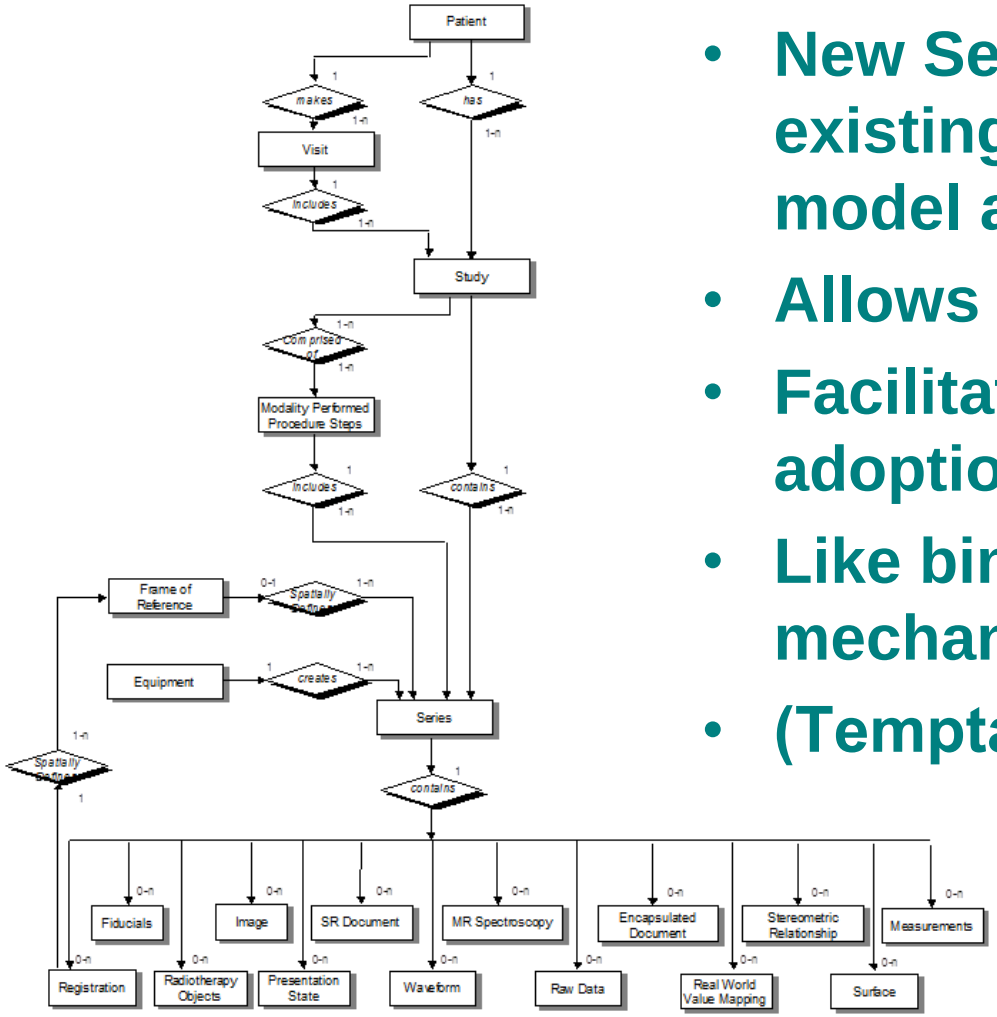






- (Association Negotiation for humans…)

Information Model Stability



- **New Services & SOPs conform to existing information/real-world model and associated semantics**
- **Allows easier implementation**
- **Facilitates proxying during adoption/transition period**
- **Like binding to different transport mechanisms**
- **(Temptation to “improve”)**

DICOM Model Elements

An Image (or other IODs) holds acquired data

A Series may group closely related Images from the same PPS, same protocol & same piece of Equipment

A Study groups all Series for a given Req. Procedure

A Patient may have many studies

Instances are actual data created based on an object definition

DICOM uses Unique Identifiers (UIDs) to identify:

- specific Instances
- specific SOP Classes
- specific Study / Series
- . . . and many other things

Starting from the bottom ...

Service Class User

MR Storage SOP Class

Service Class Provider

Storage Service

+

MR Object

Module Module Module

Attribute Attribute Attribute

DICOM Terms: Attribute

DICOM Data Stream **= …00100010Smith^John^^^…**

Tag	*Attribute Name*	*VR*	*VM*	*Value*
(**0010**,**0010**)	Patient Name	PN	1	**Smith^John^^^**

(See DICOM Part 6: Data Dictionary)

- **Tag: (Group #, Element #)**
  to identify an attribute/data element
- **Value Representation (VR):**
  data type used to encode the value(s)
- **Value Multiplicity (VM):**
  how many values can be in the attribute

DICOM Terms: Module

DICOM
Digital Imaging and Communications in Medicine

Patient Module

Attribute	*Tag*	*Type*	*Attribute Description*
Patient Name	(0010,0010)	2	Patient's Full Name
Patient ID	(0010,0020)	2	Primary hospital identification number or code for the patient
Issuer of Patient ID	(0010,0021)	3	Identifier of the Assigning Authority that issued the Patient ID
…			

(See DICOM Part 3: Information Object Definitions)

- **Module: an architectural convenience; a logical group of attributes about a common topic**
- **Macro: purely an editing convenience; a table of attributes that can be easily copied into modules**
- **Type: (1) Required (2) May Be Empty if Unknown (3) Optional (1C or 2C) Conditional**

DICOM Terms: Object (IOD)

Enhanced CT Object

IE	*Module*	*Reference*	*Usage*
Patient	Patient	C.7.1.1	M
…			
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Contrast/Bolus	C.7.6.4	C – Required if contrast media was used in this image
	CT Image	C.8.2.1	M

(See DICOM Part 3: Information Object Definitions)

Information Entity (IE): a group of modules representing a Real-World object

Reference: a Section in Part 3 where it is defined

Usage: (M) Mandatory; (C) Conditional; (U) Optional

DICOM Services

Print – **Printing Objects to a DICOM Printer**

Storage – **Storing Objects, e.g. to a PACS**

Query/ Retrieve – **Getting Objects, e.g. from a PACS**

MWM – **Getting Scheduled Patients, e.g. from RIS (Modality Worklist Management)**

MPPS – **Status (Started, Completed) back to RIS (Modality Performed Procedure Step)**

. . .

(See DICOM Part 4: Service Class Specifications)

The DICOM Standard

DICOM℠
Digital Imaging and Communications in Medicine

Administered and Published by:

- ***NEMA (National Electrical Manufacturers Association)***
  and it's medical imaging division:
- ***MITA (Medical Imaging Technology Alliance)***

NEMA Setting Standards for Excellence

MITA MEDICAL IMAGING & TECHNOLOGY ALLIANCE A DIVISION OF NEMA

Intellectual Property

- ***DICOM Trademark and Copyright is held by NEMA***
- ***No license required to use the DICOM Standard in products***

dicom.nema.org

- ***Download free electronic copies of the Standard***
  - *All 20 Parts are available in PDF and MS Word format*
  - *Paper copies are also available for purchase*
- ***Plans and activities are publicly posted***

Author Contacts

Kevin O'Donnell, MASc.

- kodonnell@tmriusa.com
- Toshiba Medical Research Institute – USA
  706 N. Deerpath Drive,
  Vernon Hills, IL 60061

Thank you for your attention !