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DICOM Overview: Stability and Evolution

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Leading Innovation >>>

DICOM: A Family of Protocols



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



**Scheduling
Exams**

**Distributing
Images**

**Acquiring
Images**

**Medical
Imaging**

**Reporting
Images**

**Managing
Images**

**Displaying
Images**

**Processing
Images**

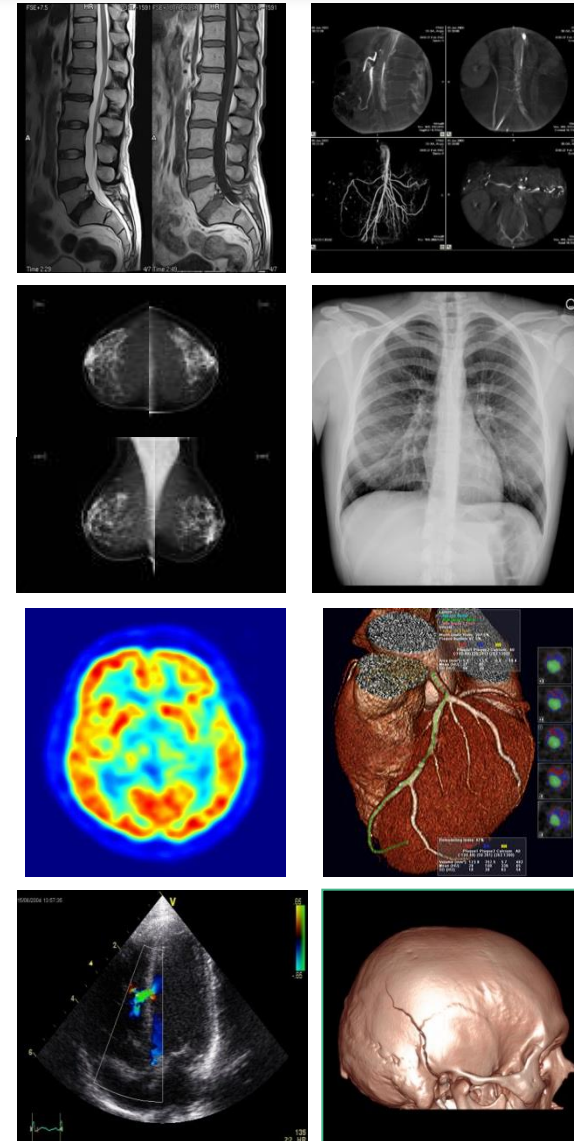
Store Images

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

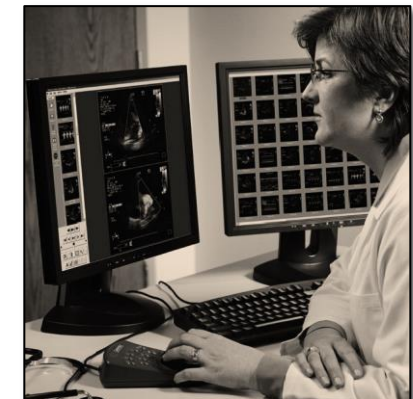
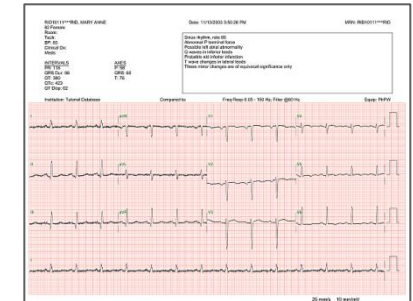
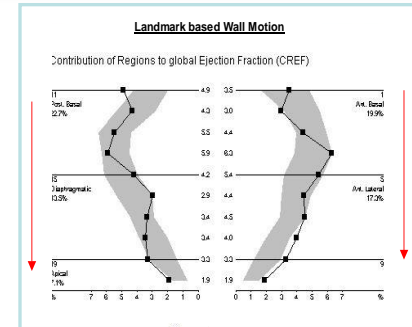
- fetal growth, cardiac output, tumor size, CAD findings, ECG Waveforms

Manage (Imaging) Workflow

- Modality Worklists, Progress updates, Storage Commitment

Display Images

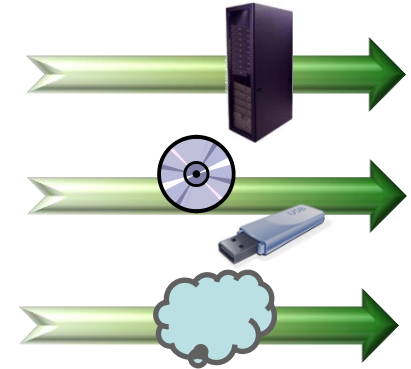
- Screen calibration, annotations, layouts, key image flagging



Other DICOM Components

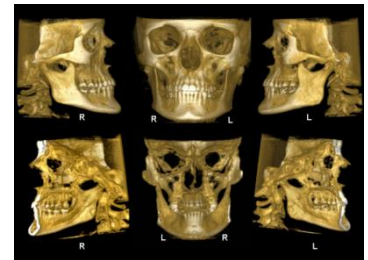
Distribute Images

- 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

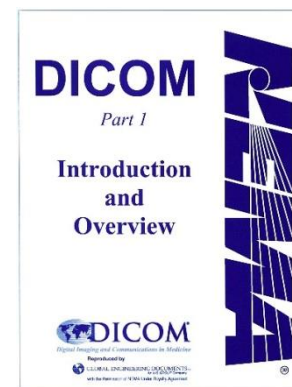
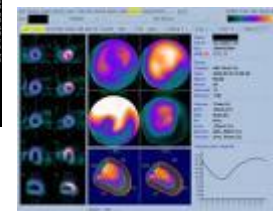
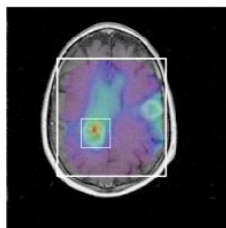


DICOM is not Static

DICOM 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

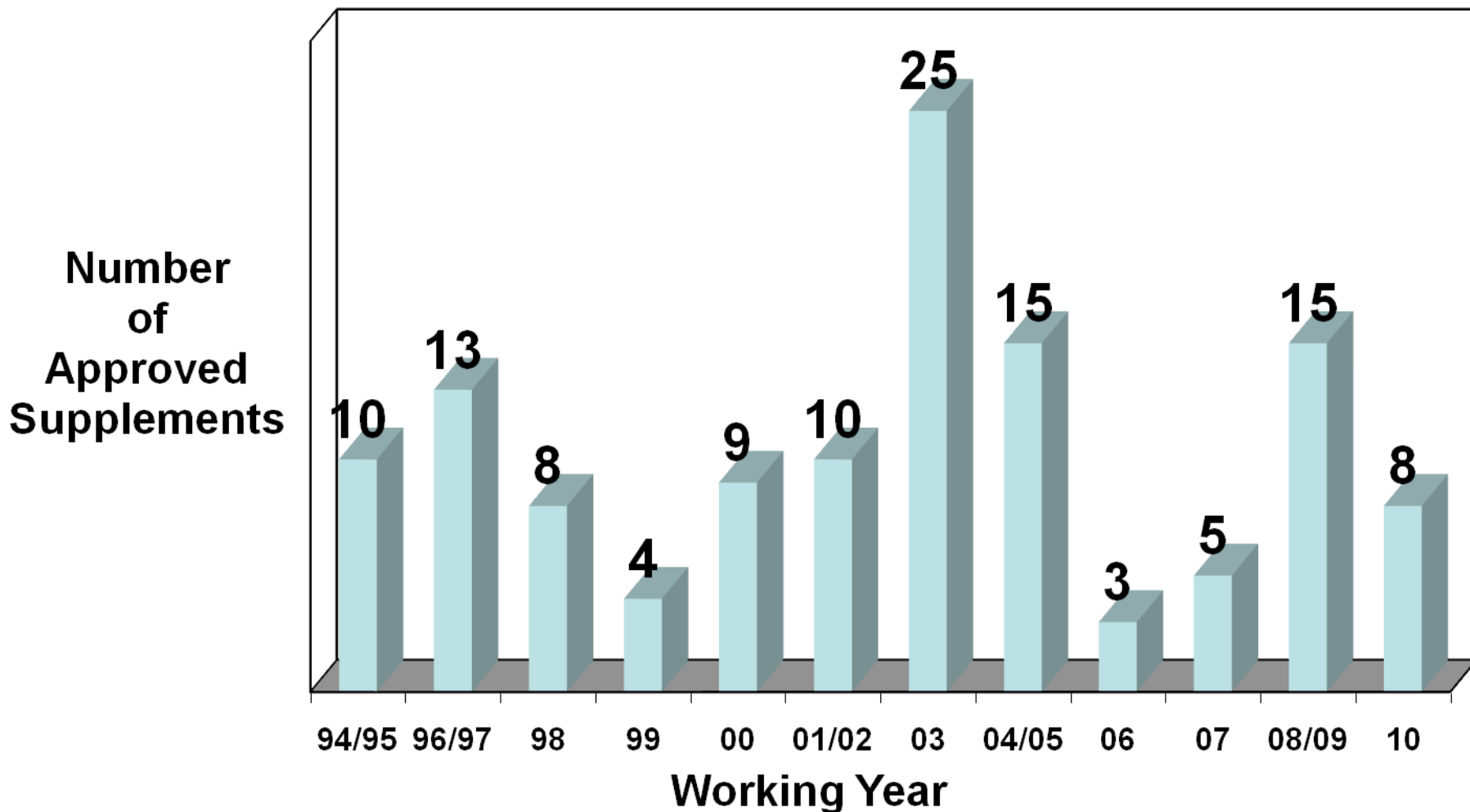
Change Proposals for minor corrections

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

Consolidated edition published every year (or less)

- Most recently, mid-2014
- Available free at DICOM web site
- Vendors responsible for monitoring final text changes

DICOM Supplements



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

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

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



SCU

MR Image Storage SOP Class



SCP

SCP – Service Class Provider

- the system that provides the service

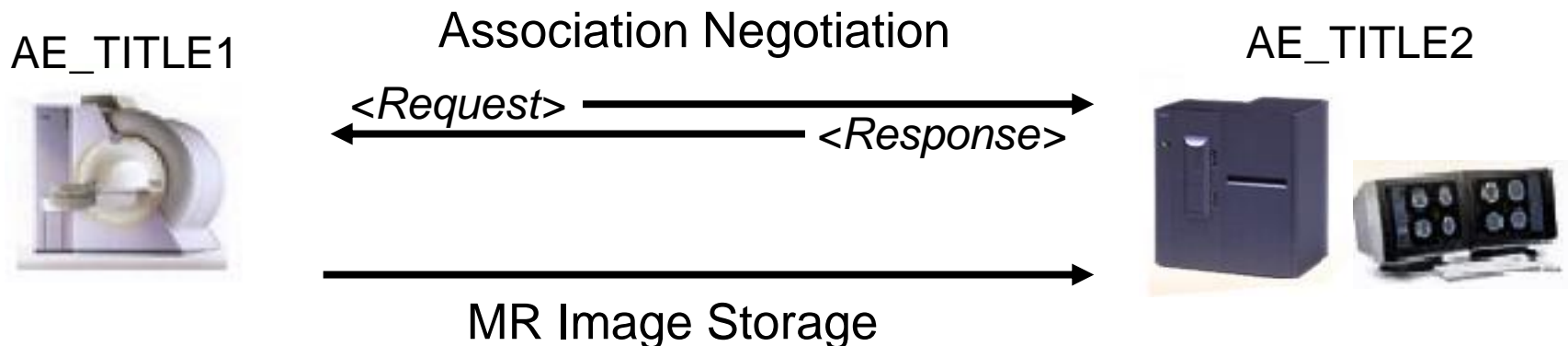
SCU – Service Class User

- the system that uses the service

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

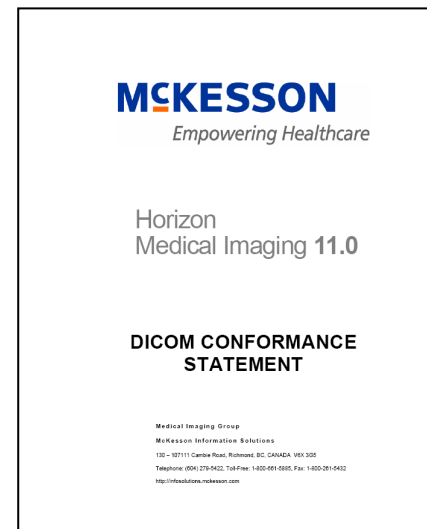
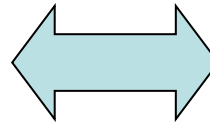
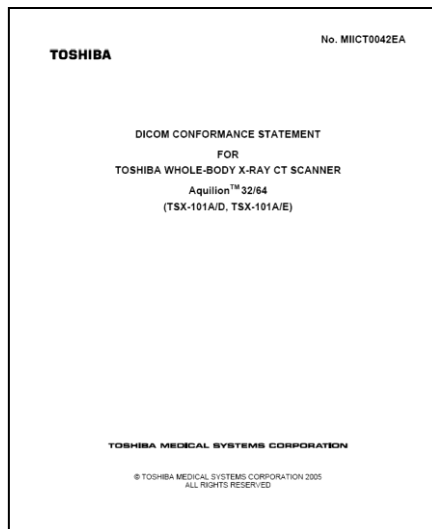
- what SOP Class they will use (e.g. MR Image Storage)
- who will be the SCU, who will be the SCP
- what the Transfer Syntax will be (e.g. JPEG Lossless)

This process is called Association Negotiation



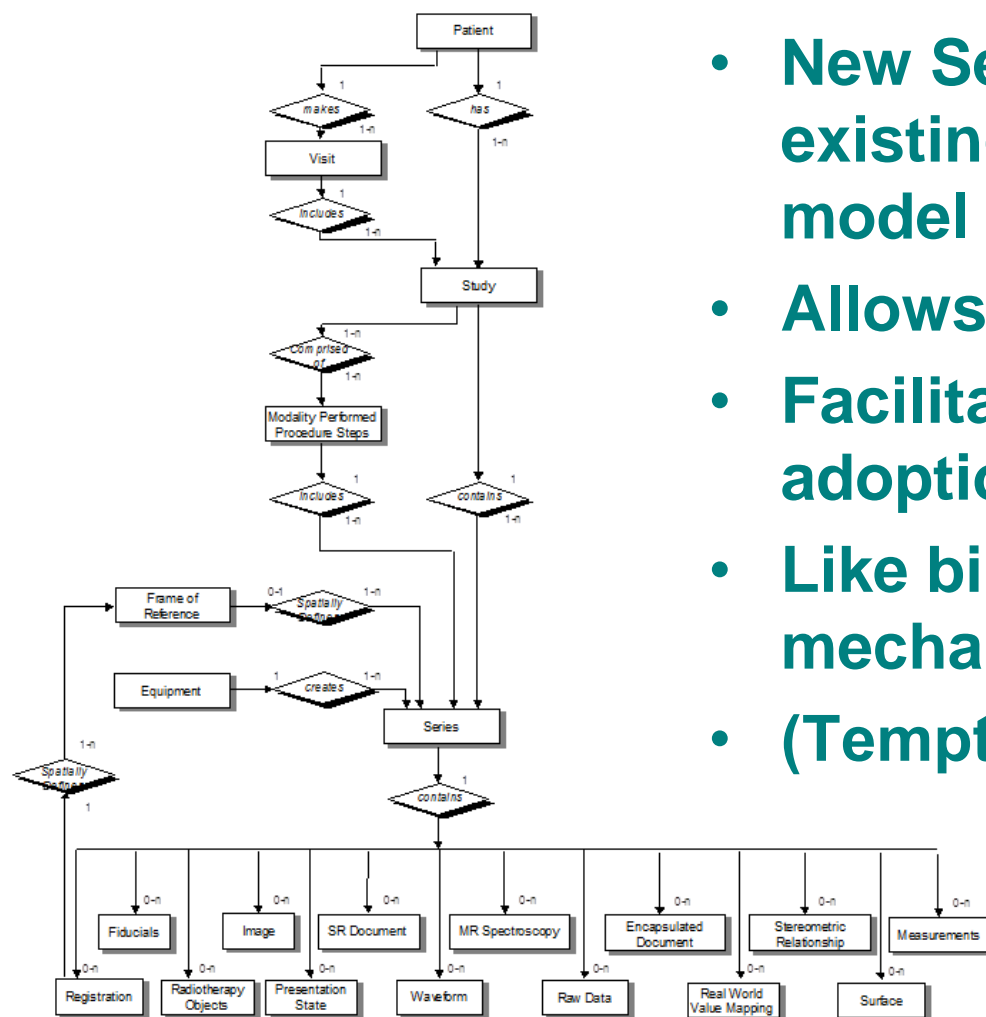
DICOM Conformance Statement

- 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”)**

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

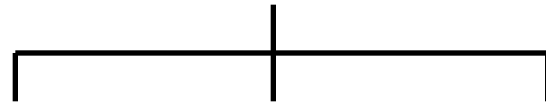


Service
Class
Provider

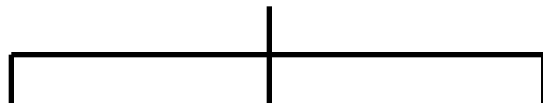
Storage Service

+

MR Object



Module Module Module



Attribute Attribute Attribute

DICOM Terms: Attribute

DICOM Data Stream = ...00100010Smith^John^^^...

<i>Tag</i>	<i>Attribute Name</i>	<i>VR</i>	<i>VM</i>	<i>Value</i>
(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



Patient Module

<i>Attribute</i>	<i>Tag</i>	<i>Type</i>	<i>Attribute Description</i>
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

<i>IE</i>	<i>Module</i>	<i>Reference</i>	<i>Usage</i>
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

- 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



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



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Thank you for your attention !