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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,  
...

**Scheduling  
Exams**

**Distributing  
Images**

**Acquiring  
Images**

**Medical  
Imaging**

**Reporting  
Images**

**Managing  
Images**

**Displaying  
Images**

**Processing  
Images**

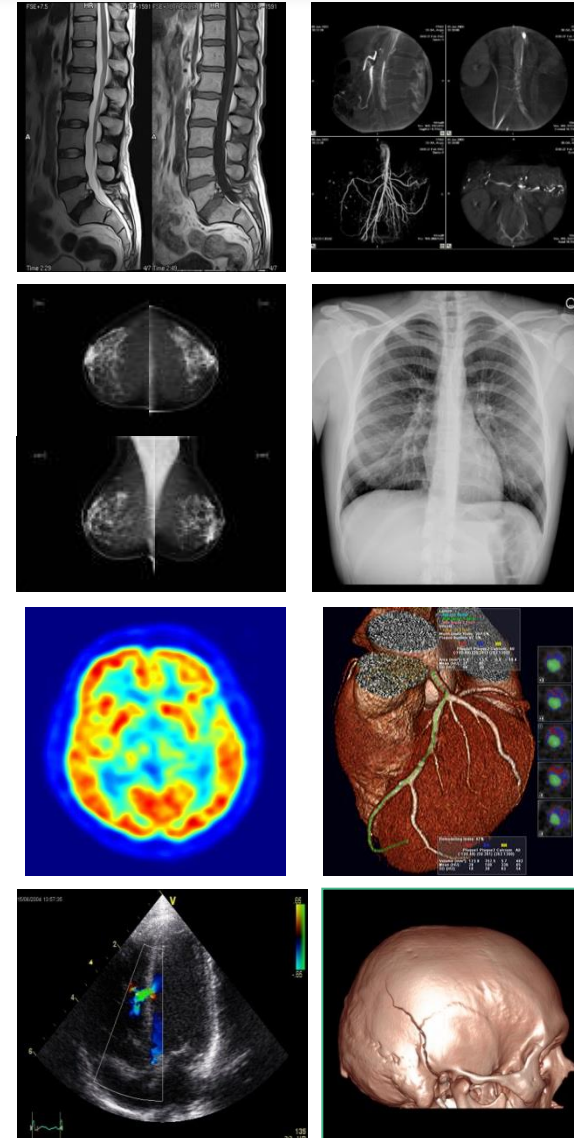
# Store Images

## 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

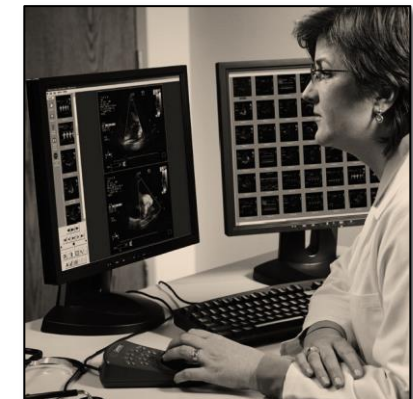
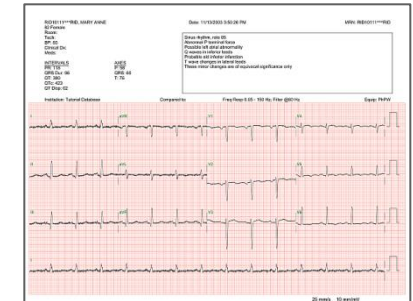
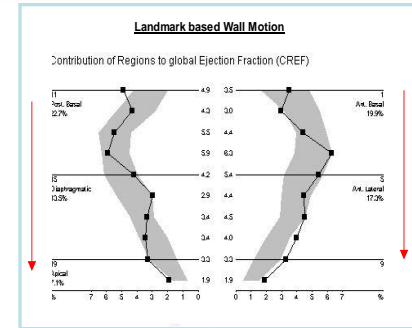
- fetal growth, cardiac output, tumor size, CAD findings, ECG Waveforms

## Manage (Imaging) Workflow

- Modality Worklists, Progress updates, Storage Commitment

## Display Images

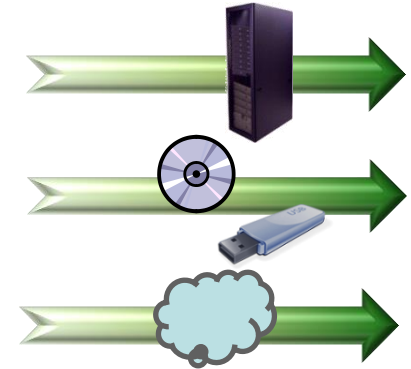
- Screen calibration, annotations, layouts, key image flagging



# Other DICOM Components

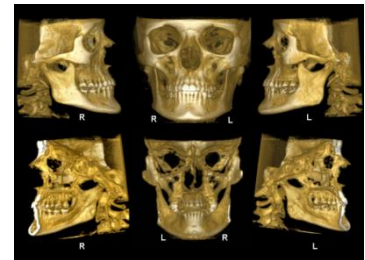
## Distribute Images

- 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

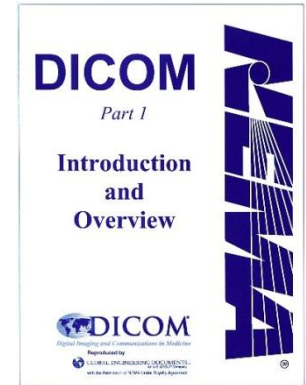
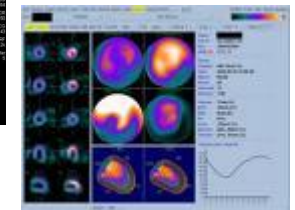
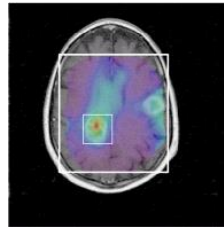


# DICOM is not Static

## 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 . . .



## 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

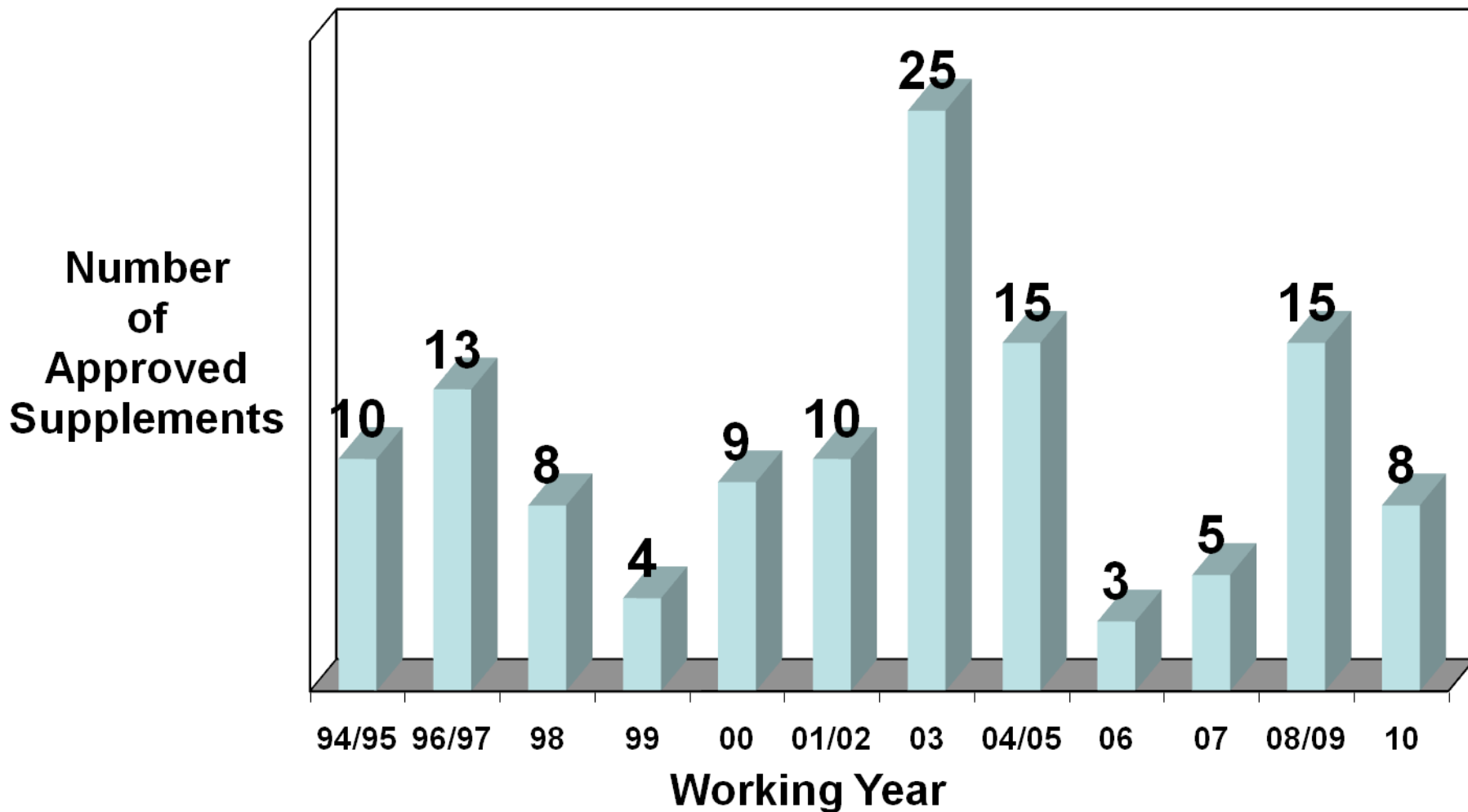
- About 100 / year
- Anybody can submit
- **Backward Compatibility:** Avoid changes that break existing implementations

## Consolidated edition published several times per year

- 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**

**WG-31: Conformance**

# Maintaining Stability

Extension, not “Versioning”

- **It’s just “DICOM”;** Not DICOM 3.1, 3.2, 3.3, etc.

DICOM is a family of SOP Classes

- **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

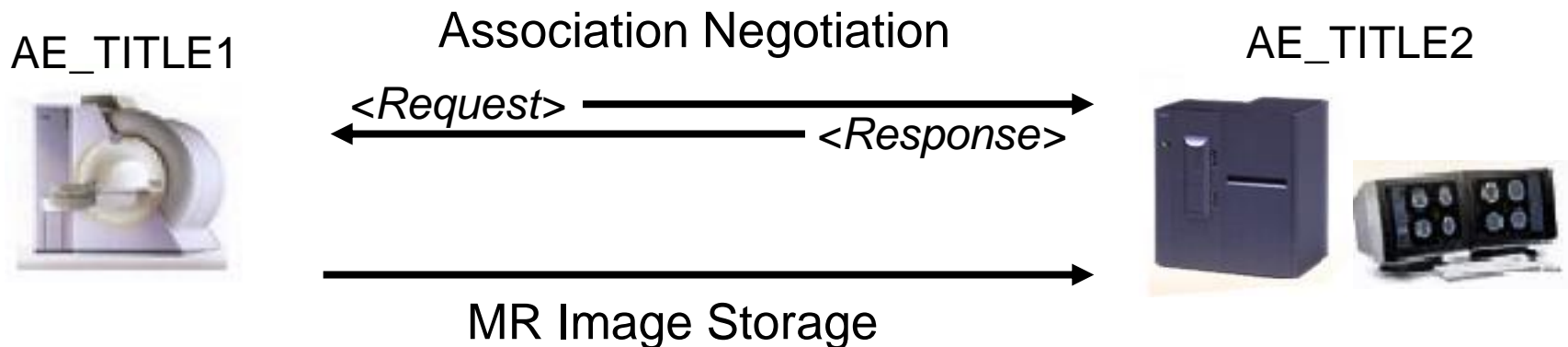
## **SCU – Service Class User**

- 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)

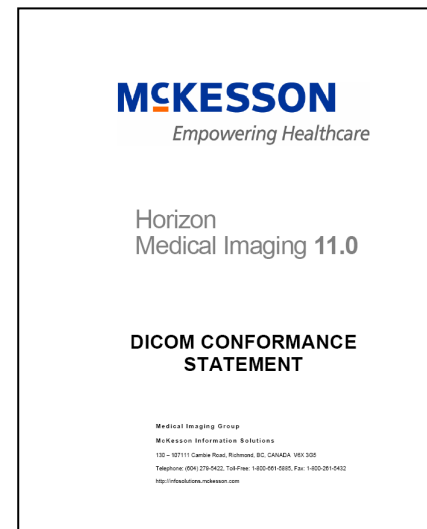
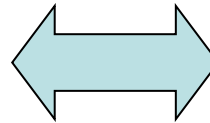
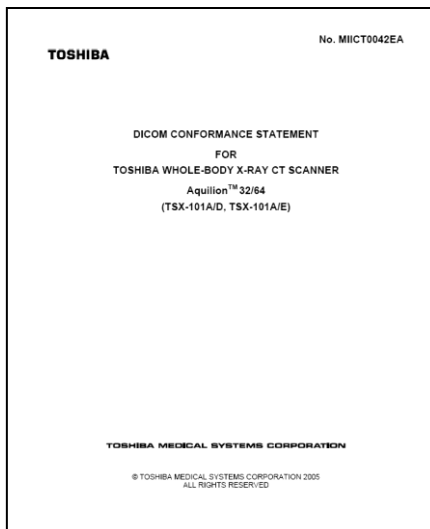
**This process is called Association Negotiation**



## DICOM Conformance Statement

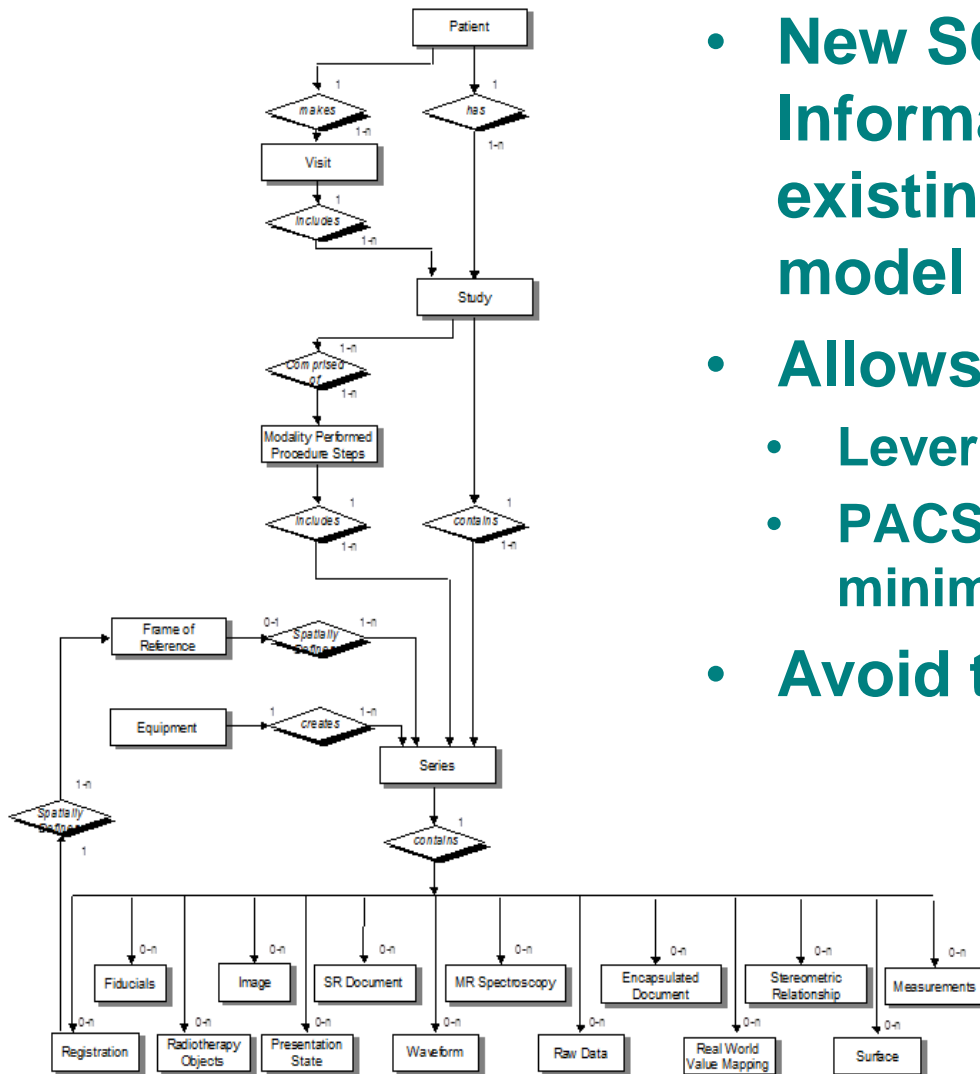
- lists the **SOPs** supported by a product
- describes product implementation details and behaviors

(See *DICOM Part 2: Conformance*)



- (Association Negotiation for humans...)

# Information Model Stability



- **New SOP Classes and Information Objects conform to existing information/real-world model**
- **Allows reuse in implementation**
  - Leverage standard modules in toolkits
  - PACS can handle new objects with minimal change
- **Avoid 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^^^...**

<b>Tag</b>	<b>Attribute Name</b>	<b>VR</b>	<b>VM</b>	<b>Value</b>
<b>(0010,0010)</b>	Patient Name	PN	1	<b>Smith^John^^^</b>

*(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

## 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

## 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



## ***Administered and Published by:***

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



## ***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, Word, HTML, and XML format*
  - *Paper copies are also available for purchase*
- ***Plans and activities are publicly posted***

**DICOM Standard is maintained in DocBook XML and published free on the Web in multiple formats:**

- **PDF** - the official version
- **XML** - for automatic update of tools
- **HTML** - for easy use with hyperlinks to references
- **MS Word** - for extraction into project documentation

**Re-published several times per year to incorporate all approved Supplements and Change Proposals**

**<http://dicom.nema.org/standard.html>**

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***Thank you for your attention !***