DICOM Overview

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Summary

- **DICOM – Digital Imaging and COmmunications in Medicine (ISO 12052) – is *the* international standard for medical imaging and related information**
  - **One of the most widely deployed healthcare messaging standards in the world**
    - 100,000s of units, several 10's of billions of images archived

- **DICOM defines**
  - **Formats for images, waveforms, derived structured data, …**
    - with the quality and metadata necessary for *clinical use*
  - **Workflow management in the imaging department**
  - **Media exchange and printing**
  - **Service-based network protocols over TCP/IP and HTTP**

13:30 Session

The DICOM Standard

- **Administered and published by**
  - **National Electrical Manufacturers Association – NEMA**
    and it's medical imaging division
  - **Medical Imaging Technology Alliance – MITA**

- **Intellectual property**
  - **DICOM trademark and copyright is held by NEMA**
  - **No license required to use the DICOM Standard in products**

- **http://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 available for purchase
  - **Plans and activities are publicly posted**

10:30 Session

DICOM – A family of protocols

- **Protocol**
  - **Specifies how two *systems* exchange *information***

- **Many kinds of systems**
  - **Acquisition modalities, PACSs, RISs, workstations, EMRs, …**

- **Many kinds of information**
  - **Images, work lists, 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, Documents, …**
  - **Single & Multiframe; Volumes & Cines; B&W & Color; Original & Processed**

- **DICOM helps to manage your images**
  - **Not just pixels ➔ significant meta-data**
  - **Patient identification & demographics, the order, eqt, acquisition, workflow context, …**
  - **PACS = (intelligent) NAS; DICOM = machine readable**
 - **Can query / sort / autoroute / manage**
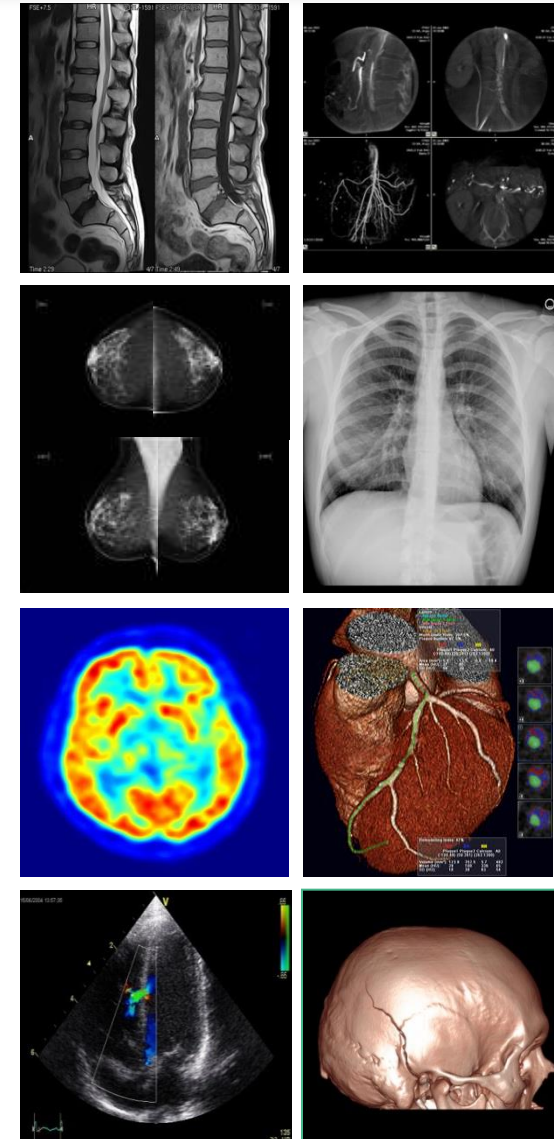
Other DICOM Components

- ## 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, …**
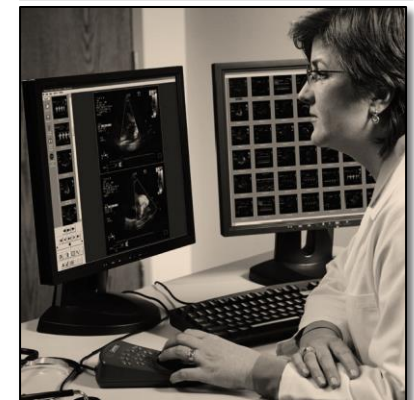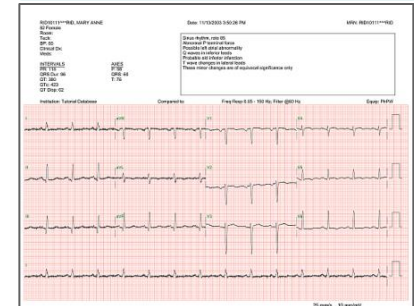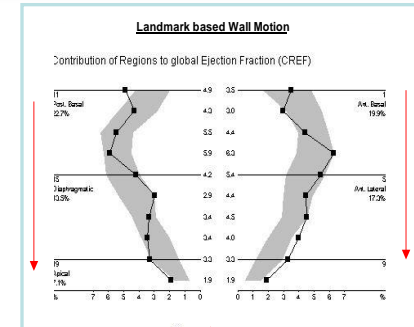
Other DICOM Components

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

- **Store Analysis Results**
  - **Registrations, Segmentations,
    Implant Models, …**

- **Secure**
  - **Audit Trails, De-identification Schemes,
    Encryption**

DICOM SOP Class
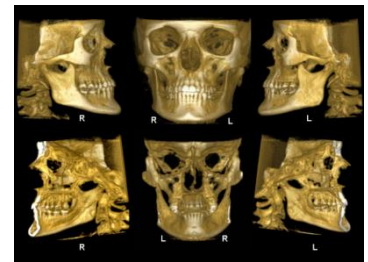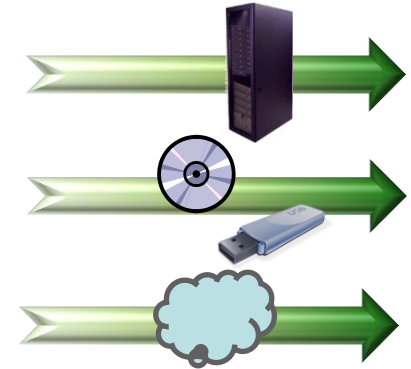
- **Service + Object = Service Object Pair**
 - **Storage + MR Image = MR Image Storage**

MR Image Storage SOP Class

SCU → SCP

- **SCU – Service Class User**
  - **the system that uses the service**
- **SCP – Service Class Provider**
  - **the system that provides the service**

DICOM Association Negotiation

- **Before two Application Entities (AE) perform a DICOM transaction they first agree on**
    - **who will be the SCU, who will be the SCP**
    - **what SOP Class they will use (e.g. MR Image Storage)**
    - **what the Transfer Syntax will be (e.g. JPEG Lossless)**
- **This process is called Association Negotiation**

AE_TITLE1
Association Negotiation
AE_TITLE2

<Request>
<Response>

MR Image Storage
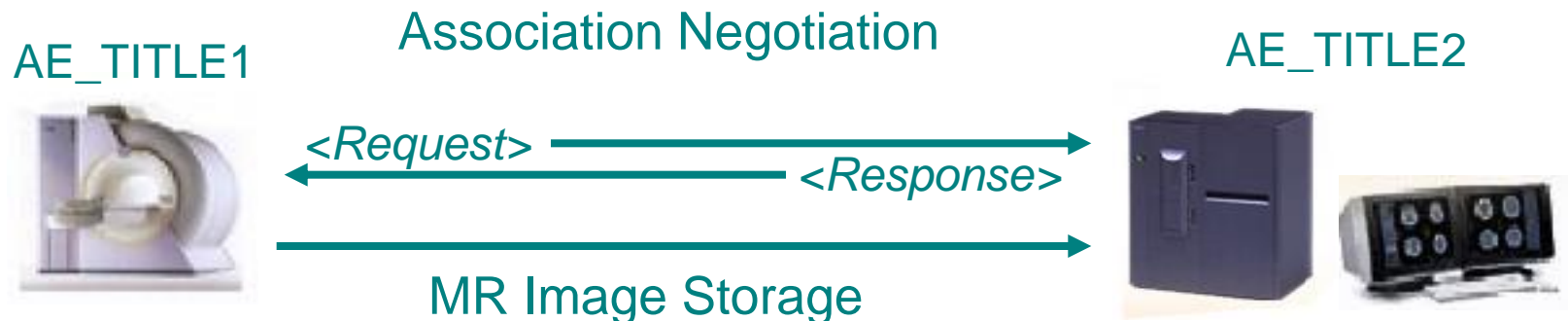
- **Note that Character Sets are not negotiated!**

DICOM Information Model
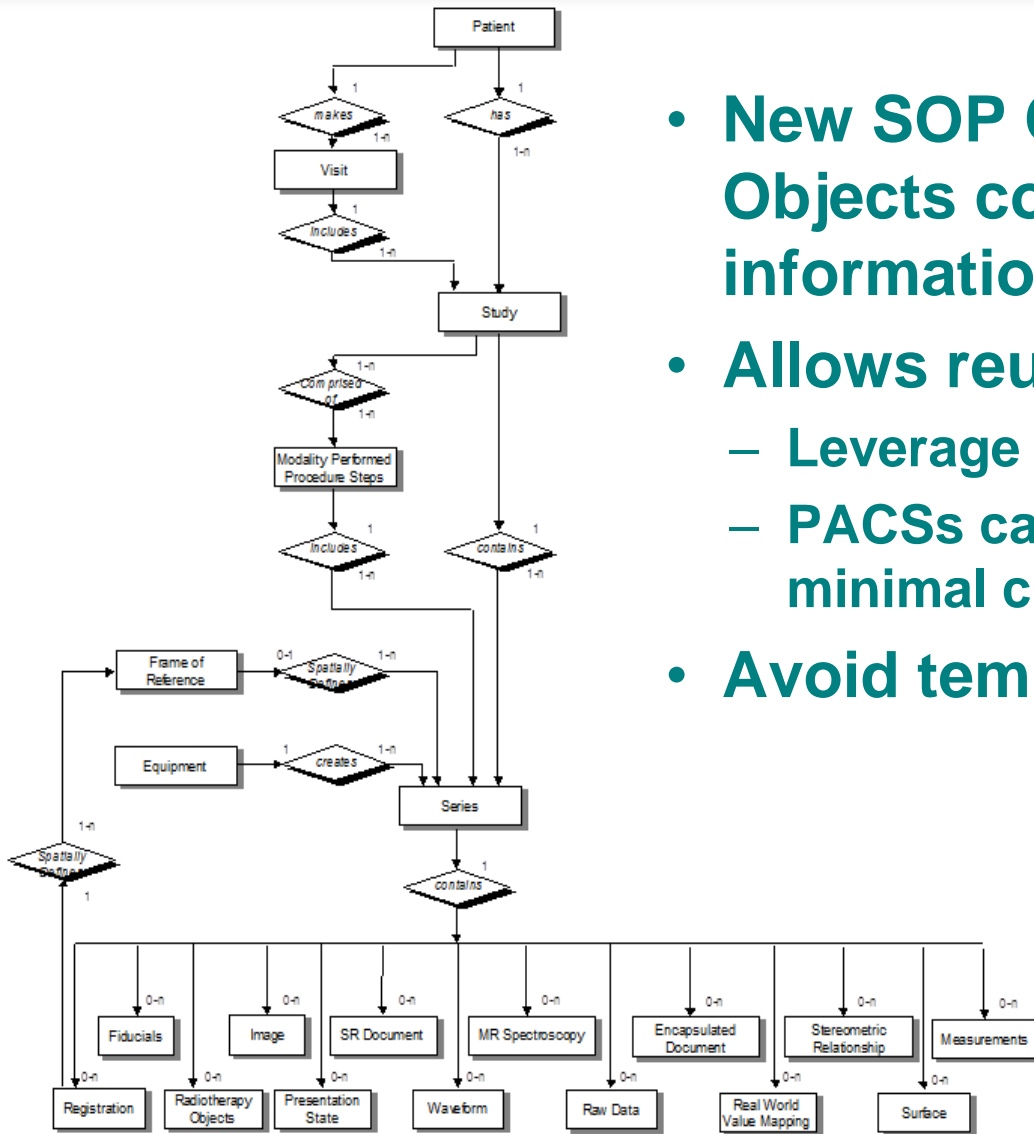
- **New SOP Classes and Information Objects conform to the existing information / real-world model**

- **Allows reuse in implementation**
  - **Leverage standard modules in toolkits**
  - **PACSs can handle new objects with minimal change**

- **Avoid temptation to 'improve'**

Information Model Elements

- An *Image* (or other object) 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 data that are structured according specific object definitions
- DICOM uses Unique Identifiers (*UID*s) for identification
    - specific Instances, SOP Classes, Study / Series, …

Image Object Definition Structure

MR Storage SOP Class

Service
Class
User

Service
Class
Provider

Storage Service

+

MR Image

Module   Module   Module

Attribute Attribute   Attribute

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 #)**
  - **Defines key of an attribute / data element**
- **Value Representation (VR)**
  - **Defines data type used to encode the value(s)**
- **Value Multiplicity (VM)**
  - **Defines how many values can be in the attribute**

Module

- **An architectural convenience; a logical group of attributes about a common topic, e.g. 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)

- **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**

Object (IOD)

| 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**
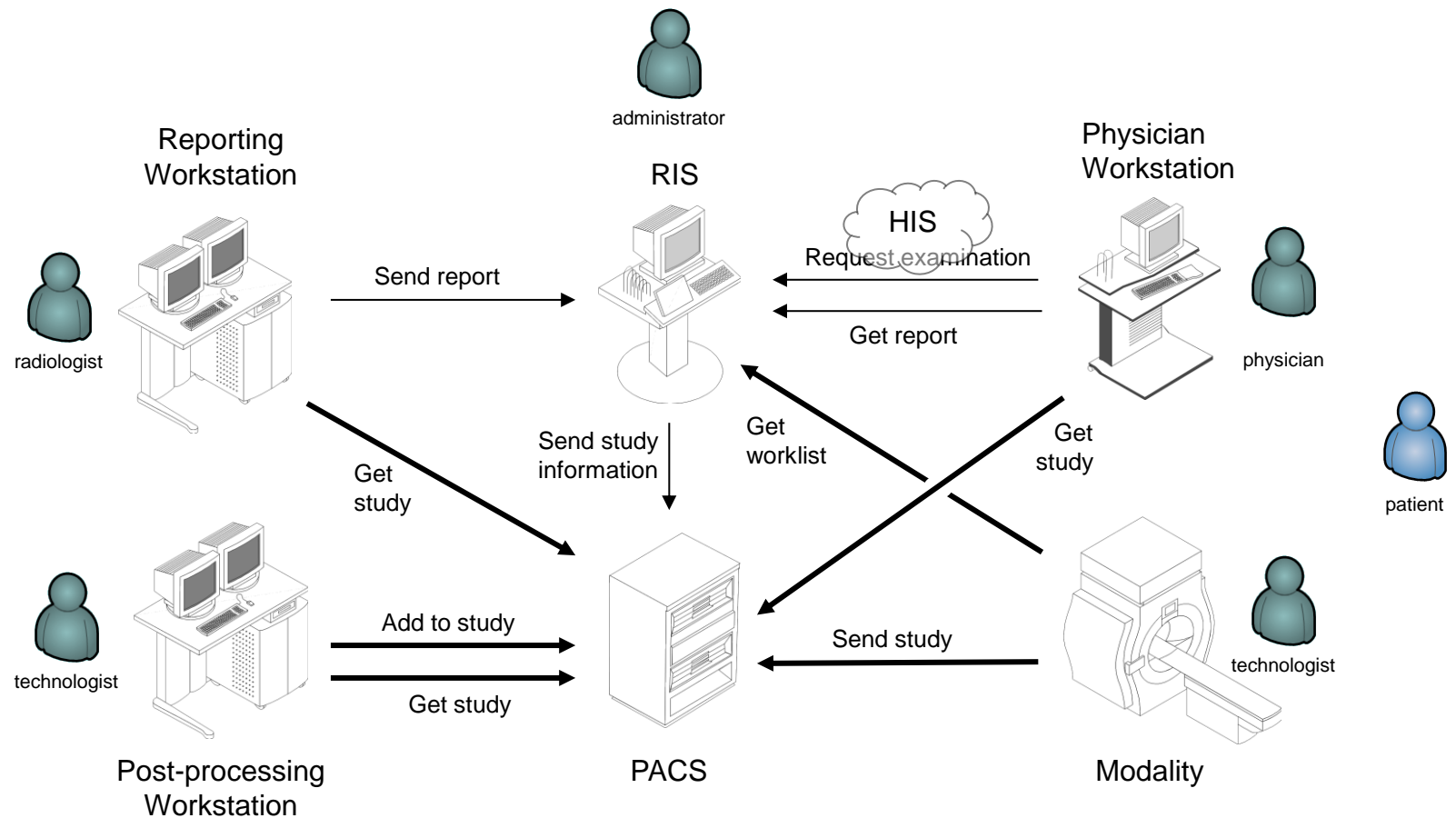 **(Modality Performed Procedure Step)**
- **. . .**

Conformance

- **DICOM Conformance Statement**
  - **Lists the DICOM building blocks a product supports**
  - **Describes product implementation details and behaviors**

    (See DICOM Part 2: Conformance)
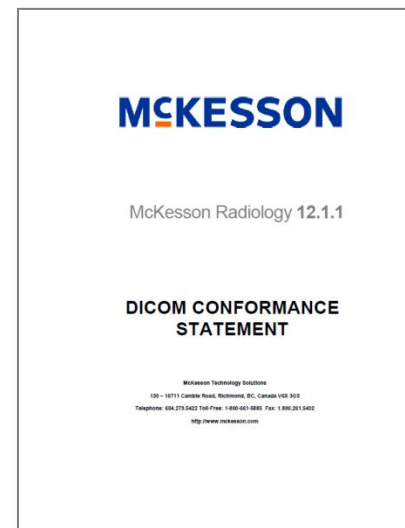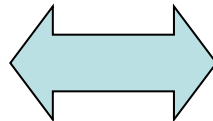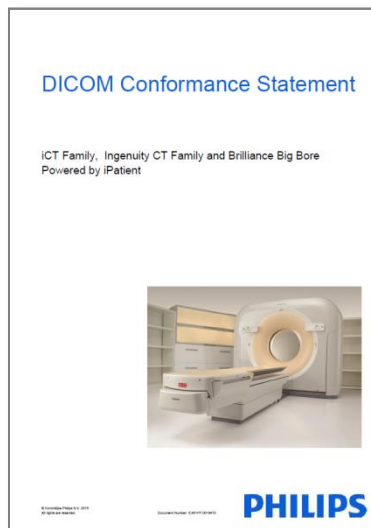
  - **'Association negotiation' for humans**

Intent of DICOM

Data and workflow interoperability

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Thank you for your attention!