

# DICOM Overview

**Jeroen Medema**

**Philips Intellectual Property and Standards  
Standardization Officer**

**Co-chair DICOM Standards Committee  
Co-chair DICOM WG31 – Conformance  
Co-chair DICOM WG29 – Education, Communication, Outreach**

- **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**

11:45 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**



# 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, ...

**Scheduling  
Exams**

**Distributing  
Images**

**Acquiring  
Images**

**Medical  
Imaging**

**Reporting  
Images**

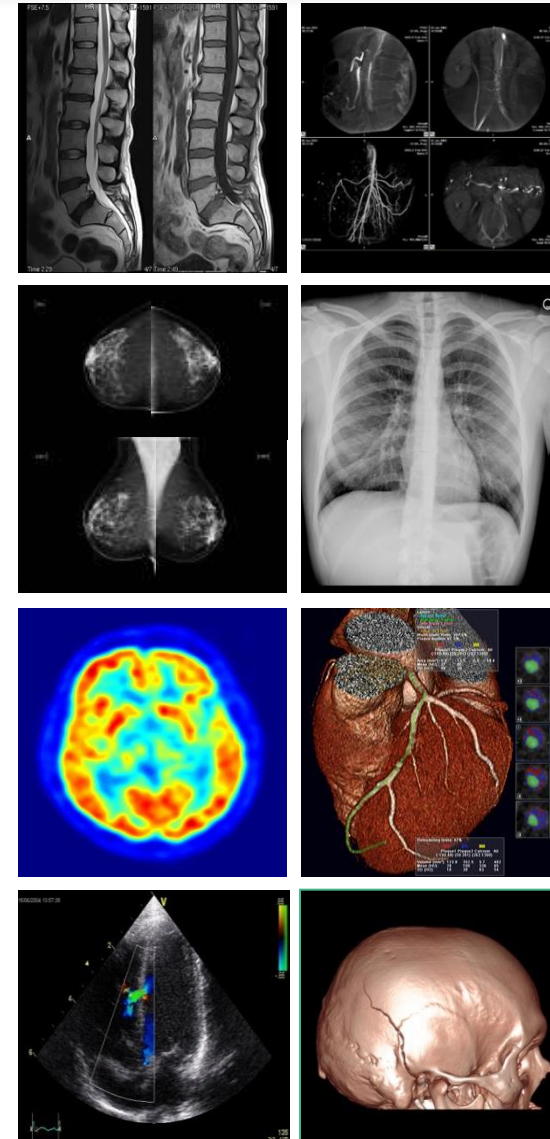
**Managing  
Images**

**Displaying  
Images**

**Processing  
Images**

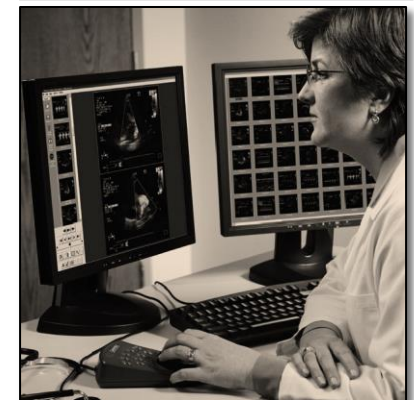
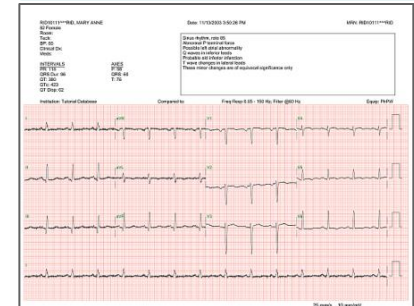
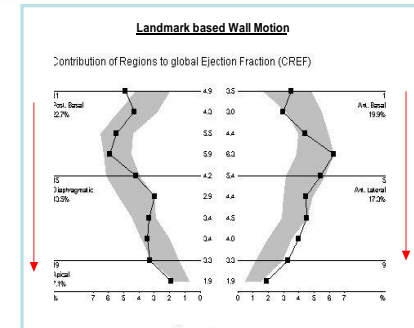
# Store Images

- **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

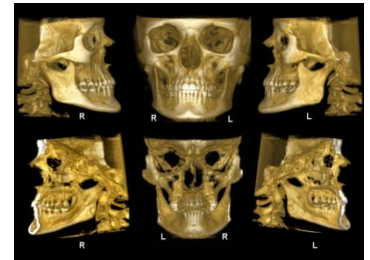
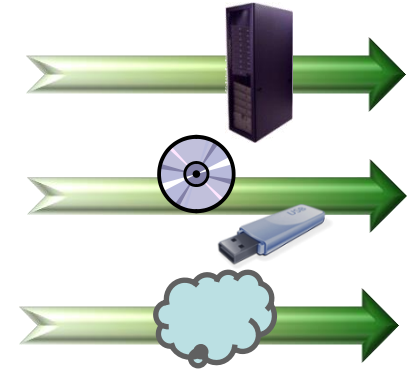


# Other DICOM Components

- **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, ...



- **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





- **Service + Object = Service Object Pair**
  - **Storage + MR Image = MR Image Storage**



SCU

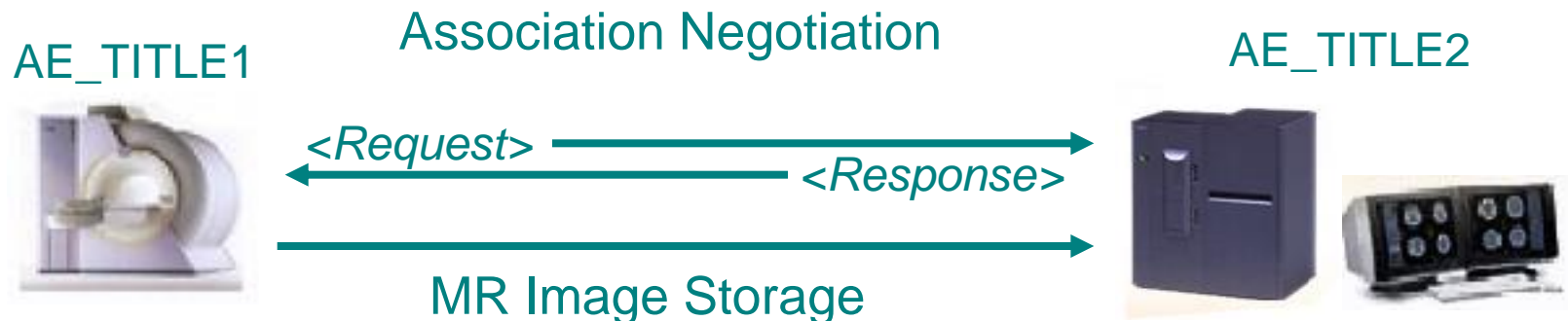
MR Image Storage SOP Class



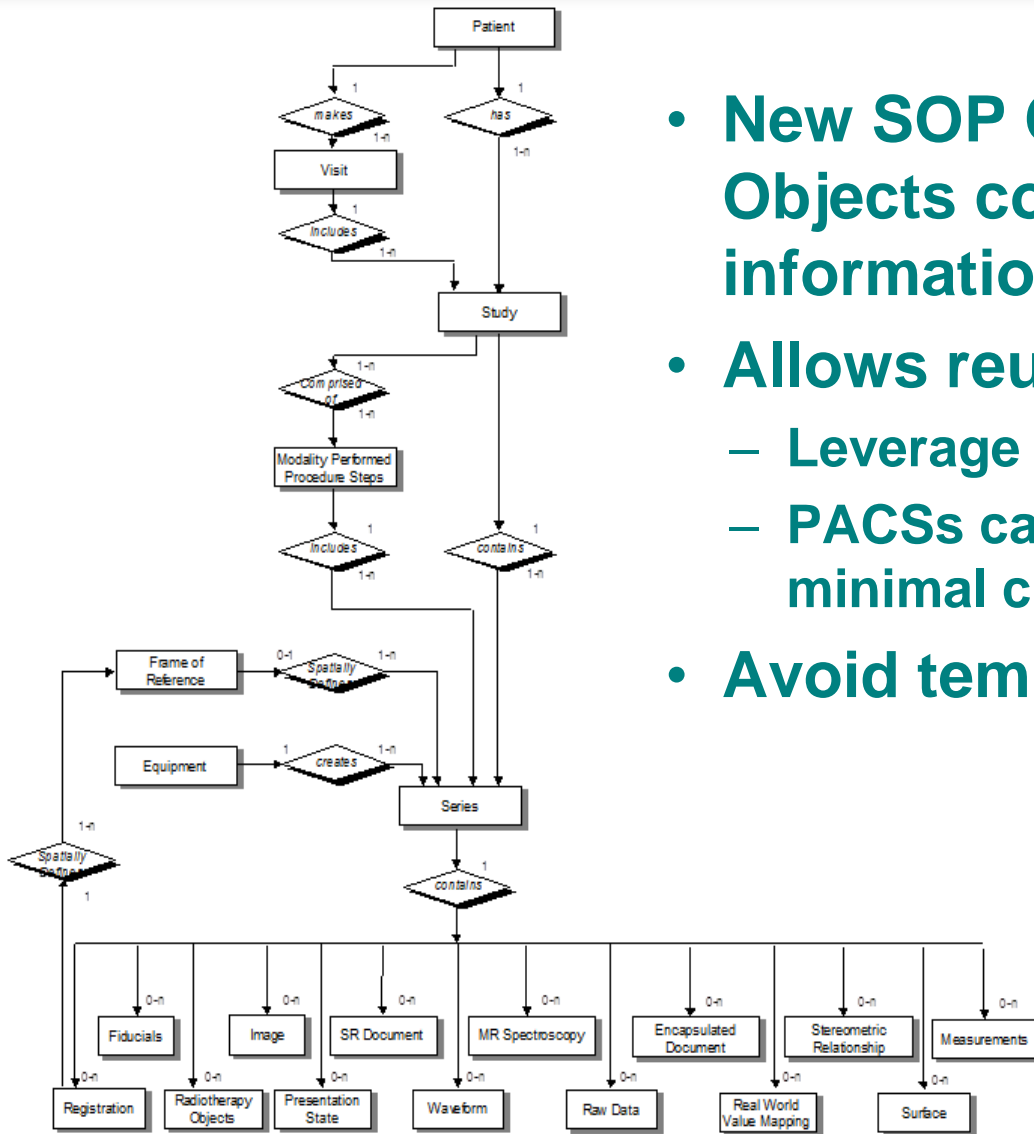
SCP

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

- **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**



- **Note that Character Sets are not negotiated!**



- **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’**

- **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 (*UIDs*) for identification**
  - specific Instances, SOP Classes, Study / Series, ...

# Image Object Definition Structure



Service  
Class  
User

MR Storage SOP Class



Service  
Class  
Provider

Storage Service

+

MR Image

Module Module Module

Attribute Attribute 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 #)**
  - 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

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

- **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**

<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)

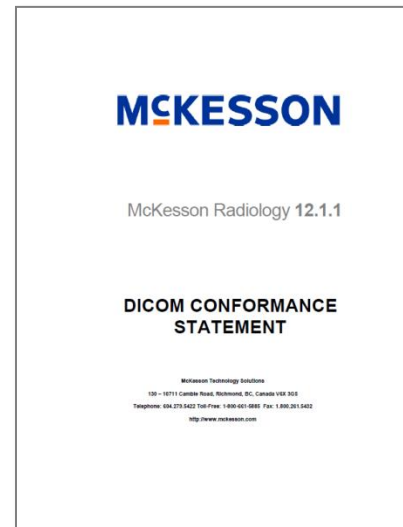
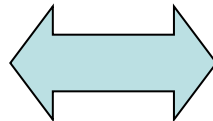
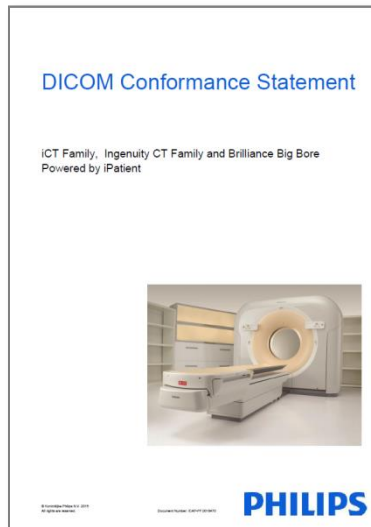
- **Information Entity (IE):** a group of modules representing a Real-World object
- **Reference:** a Section in Part 3 where it is defined
- **Usage:** (M) Mandatory; (C) Conditional; (U) Optional



- **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)
- . . .

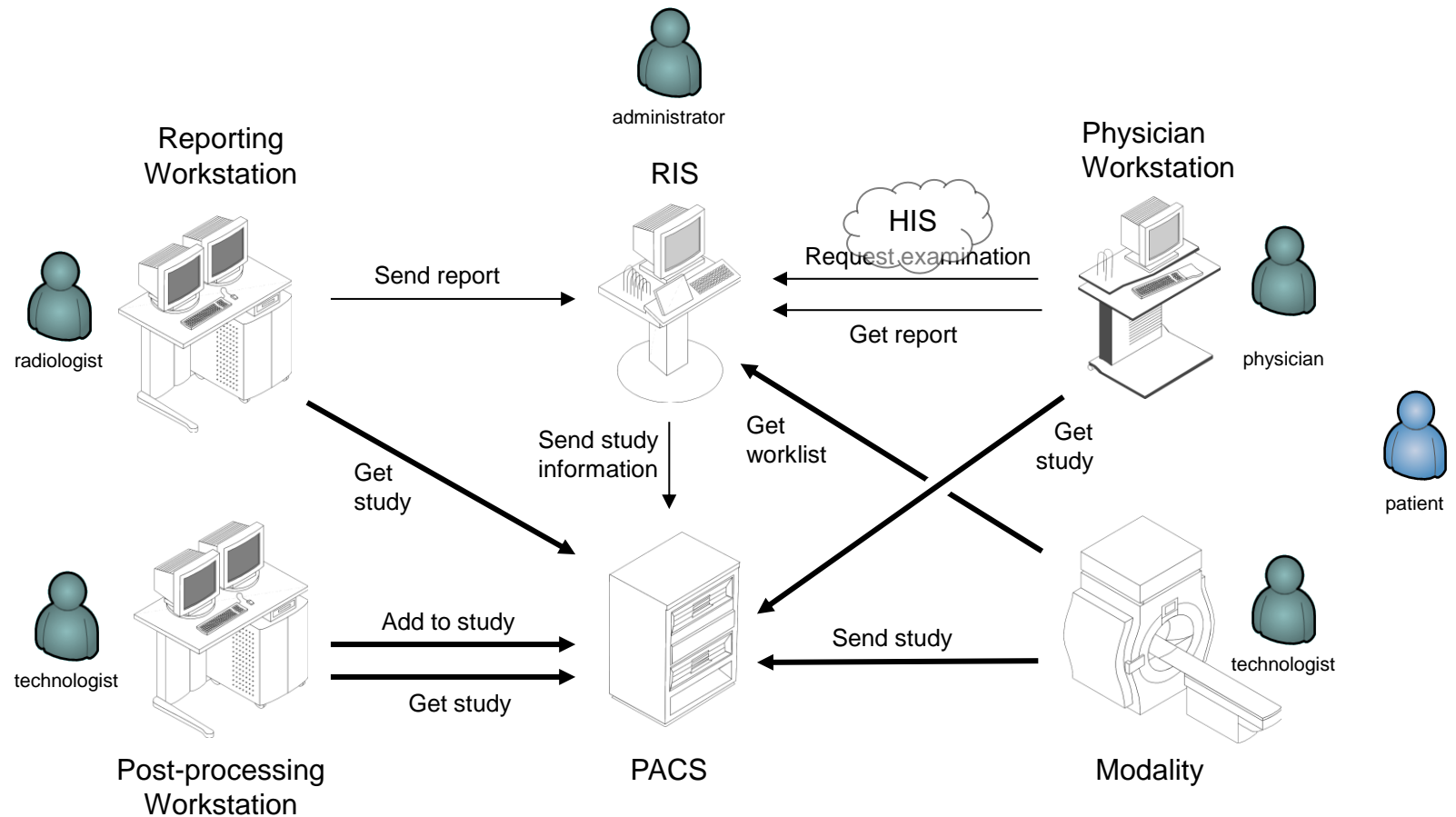
9:50 Session

- **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

## Data and workflow interoperability



- **Jeroen Medema**
  - [jeroen.medema@philips.com](mailto:jeroen.medema@philips.com)
  - **Philips Intellectual Property and Standards**  
**High Tech Campus 5**  
**5656 AE Eindhoven**  
**The Netherlands**
  - <https://nl.linkedin.com/in/jeroenmedema>



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