DICOM Educational Conference
Brisbane, Australia

SEPTEMBER 27-28, 2018

DICOM OVERVIEW & PROCESS

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CHAIR, DICOM WG10 (STRATEGIC)
PAST-CHAIR, DICOM STANDARDS CMTE
CANON MEDICAL RESEARCH USA

Canon
CANON GROUP

Made For life

DICOM: A Family of Protocols

DICOM
Digital Imaging and Communications in Medicine

Protocol

- **Specifies how two <u>systems</u> exchange <u>information</u>**
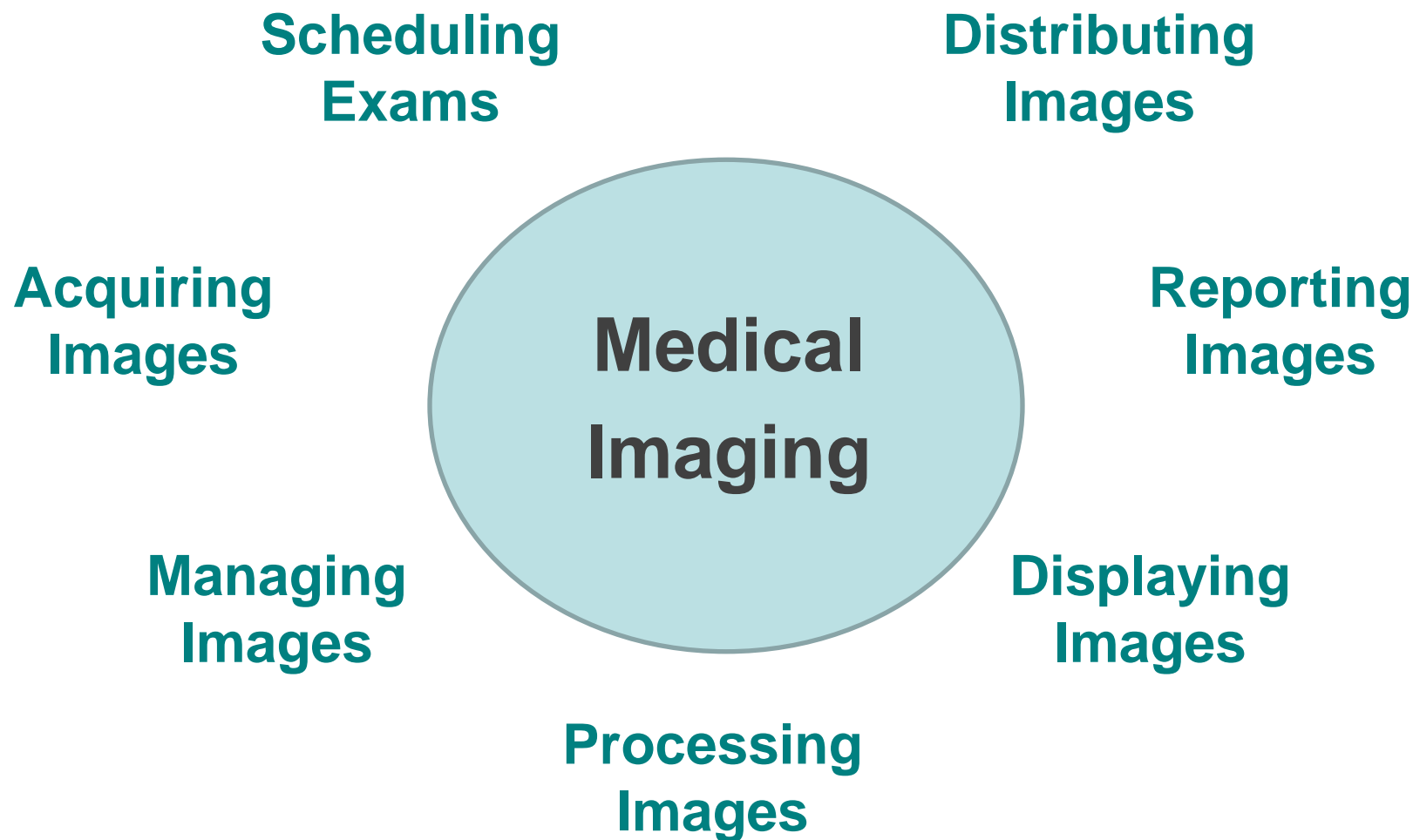
Many kinds of Systems:

- **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

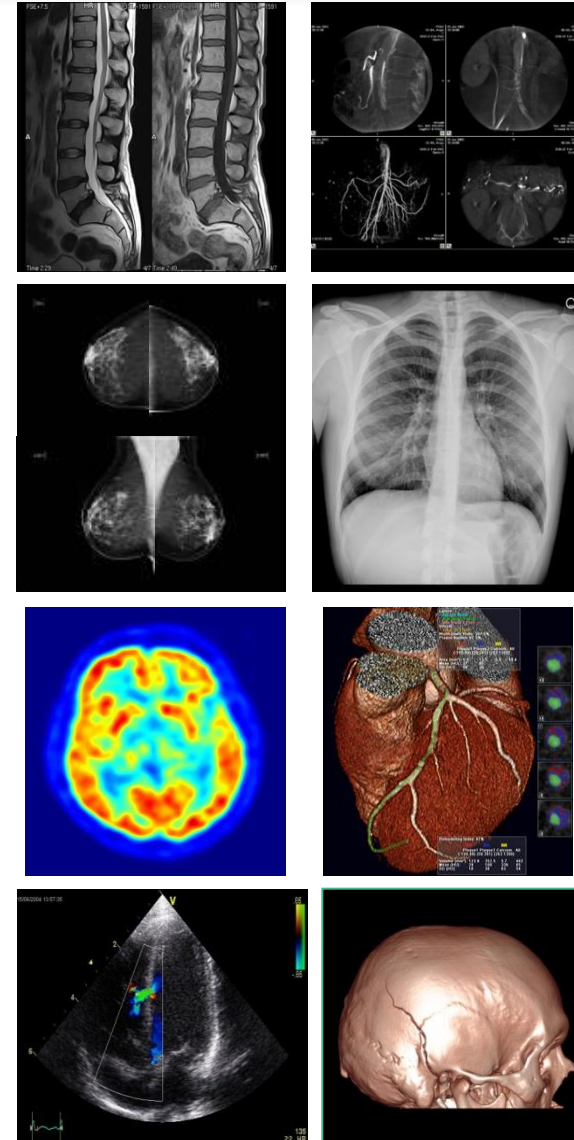Managing Images

Displaying Images

Processing Images

Store Images

DICOM stores your images

- <u>All</u> 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, equipment, acquisition, workflow, …
- PACS = database; DICOM = machine readable
- Can query/sort/autoroute/manage

Other DICOM Components

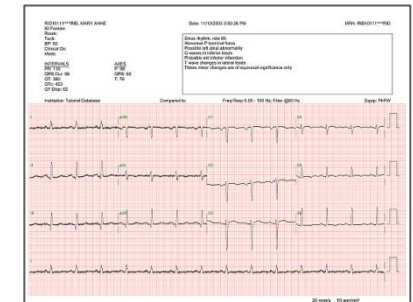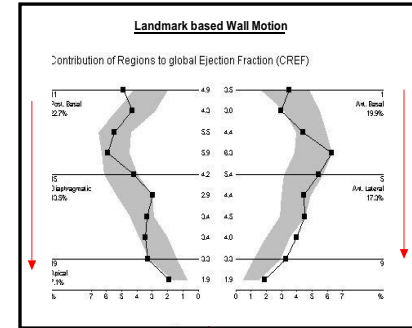
Store (Imaging) Data

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

Manage (Imaging) Workflow

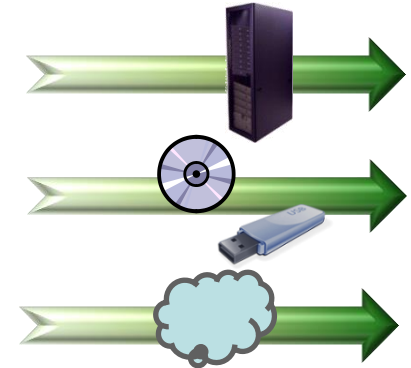- **Modality Worklists, Progress updates, Storage Commitment**

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, Image Markup,
3D Print Models, …**

## Security

- **Audit Trails, De-identification Schemas,
Encryption**

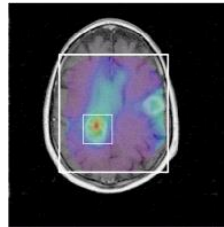# DICOM is not Static

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
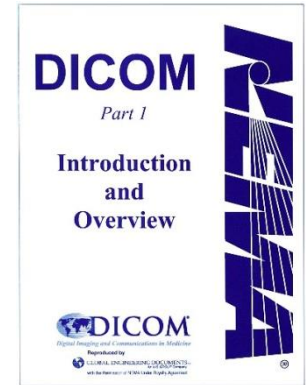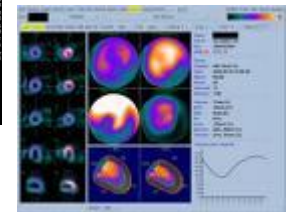
Supplements for major changes

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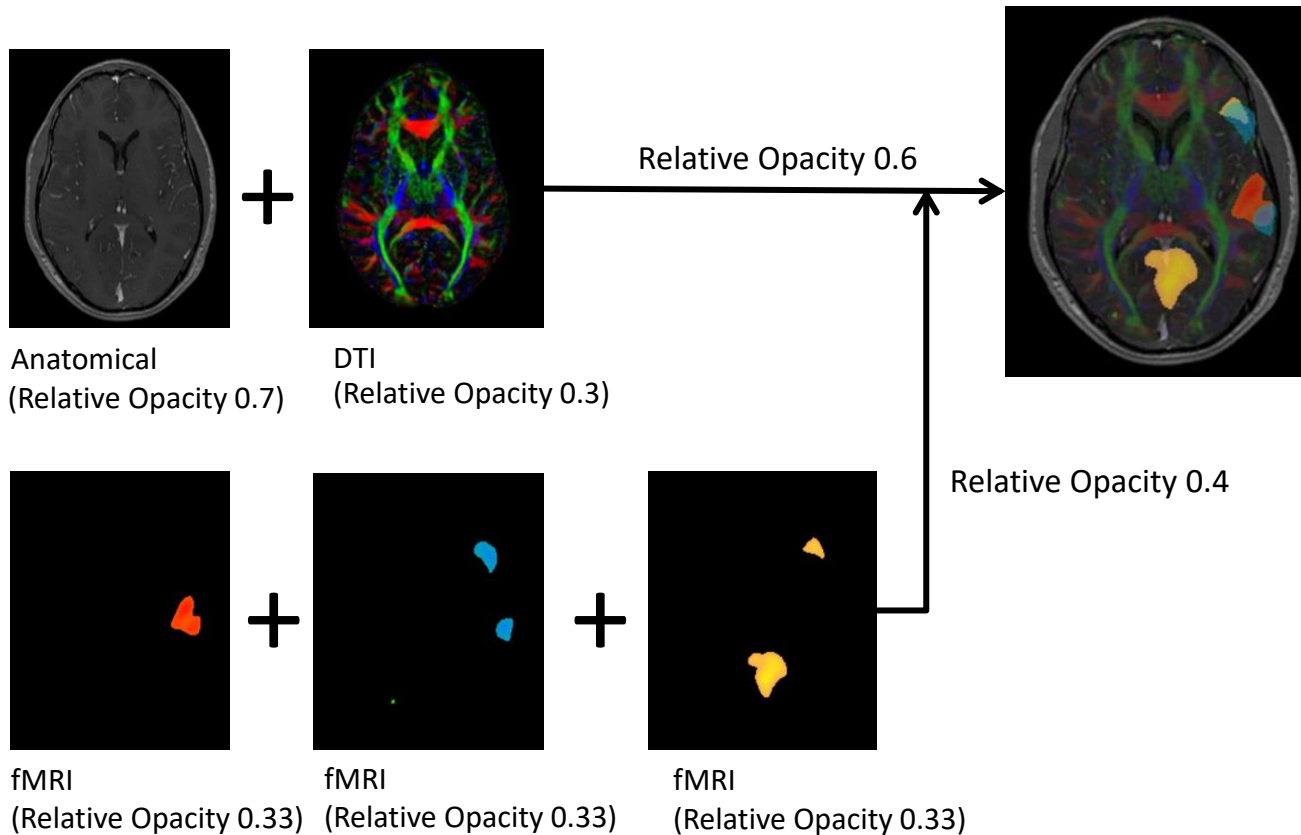- Require Work Item approved by DICOM Standards Committee

Change Proposals for minor corrections

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

Continuous maintenance process

- WG-06 ("Architecture Review Board") meets five times per year
- All documents published for open Public Comment; later formal vote by Letter Ballot

Advanced Blending Presentation State (Example)

Anatomical
(Relative Opacity 0.7)

DTI
(Relative Opacity 0.3)

Relative Opacity 0.6

Relative Opacity 0.4

fMRI
(Relative Opacity 0.33)

fMRI
(Relative Opacity 0.33)

fMRI
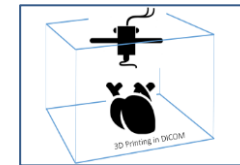(Relative Opacity 0.33)

Some Recent Supplements

- DICOMweb: RESTful Web Services

  Later Today

  - WADO, STOW, QIDO, UPS, Rendering

- CT Protocol Storage

- 3D Printing
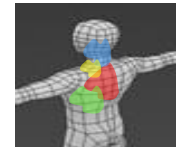
- Radiation Dose

  - X-ray, Radiopharmaceutical, Patient Dose Estimates

Patient Dose Surface

- TLS Security Update

- HEVC H265 Video Coding

- Transform NCI AIM & DICOM SR Measures

Some Current Supplements

- Sup 202 **Real Time Video**

  More Tomorrow

- Sup 147 **Second Generation Radiotherapy**
- Sup 175-9: 2nd Gen. RT continued
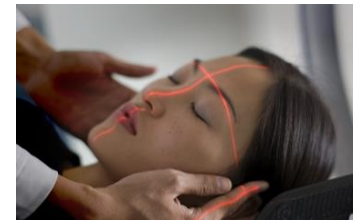
- Sup 207 **Conformity Assessment**
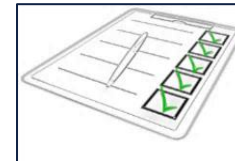
- Sup 208 **X3D Encapsulation for 3D Manufacturing**

Multi-Energy CT

Direct Angio	Lung PBV	Virtual Unenhanced	Lung Vessels
Hardplaque Display	Heart PBV	Calculi Characterization	Brain Hemorrhage
Musculoskeletal	Gout	Lung Nodules	Xenon
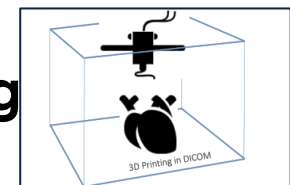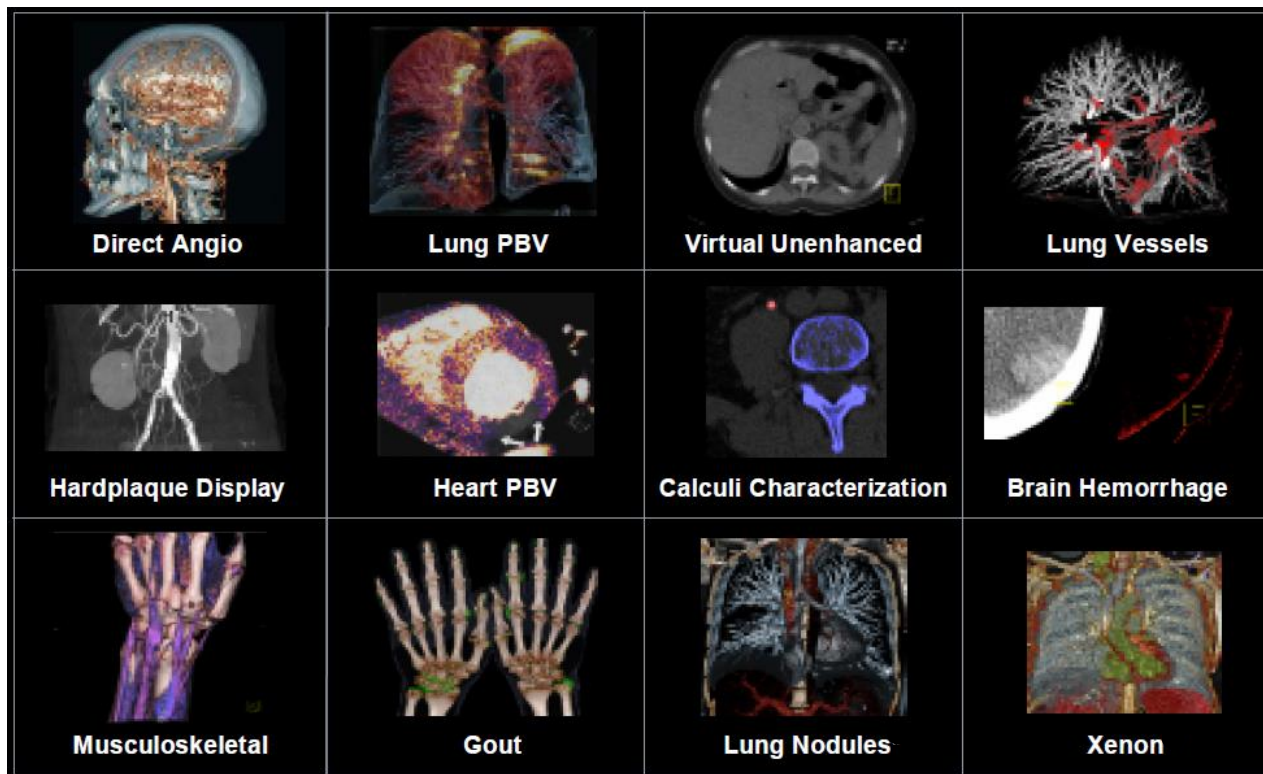
Contrast Administration SR

Performed Administration SR

Contains

Programmed at injector device

1

Actually delivered by injector device

1

Programmed Plan

Delivered Plan

1-n

1-n

Steps

Steps

Pressure Vs. Time Graphs

Flow Rate Vs. Time Graphs

1-n

1-n

Phases

Phases

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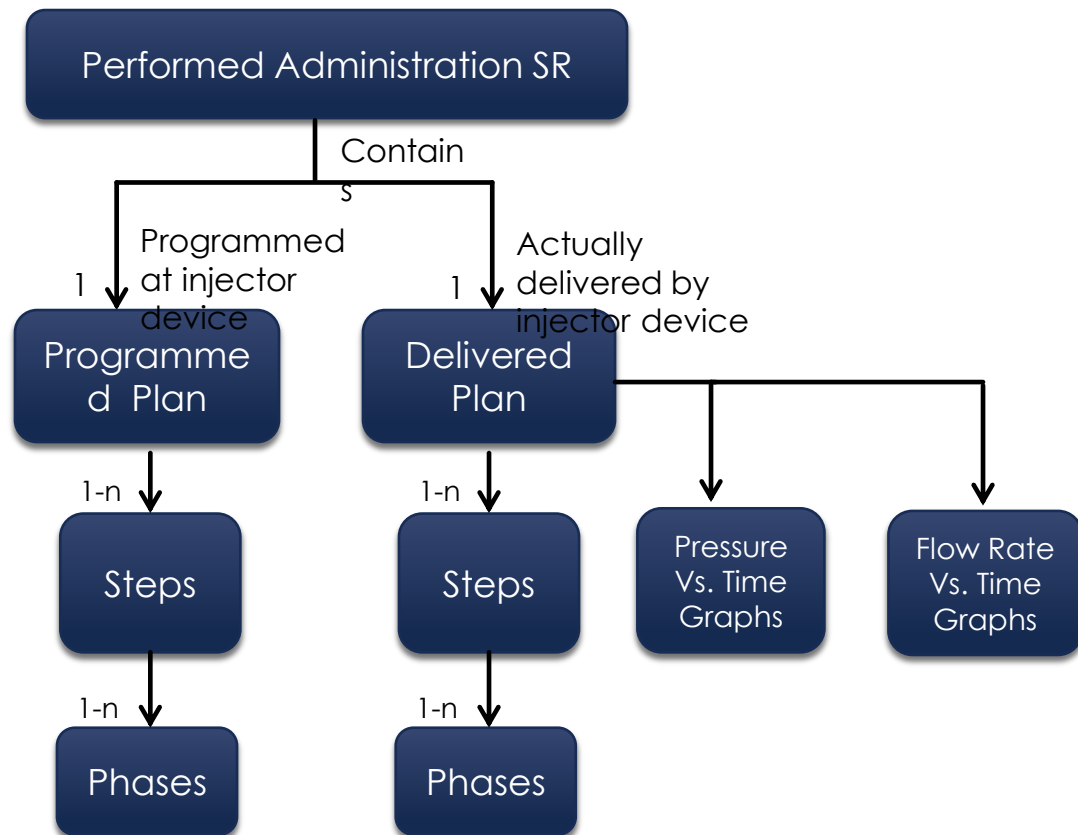
Modality, clinical domain, or function specific teams, assigned to develop Supplements or Change Proposals

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

- **No "Versioning"**
  - **It's just "DICOM"
    Not "DICOM 3.1", "3.2", "2015b", etc.**

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 (client)

SCP – Service Class Provider

• the system that provides the service (server)

Some Other SOP Examples

SOP Class = service and object

- Store a CT image
- Store an XR image

- Find the studies for a patient
- Find the worklist for a modality

- Move a set of images

- Create an image print job

Maintaining <u>Stability</u>

- **No "Versioning"**
  - **It's just "DICOM"
    Not "DICOM 3.1", "3.2", "2015b", etc.**

- **DICOM evolves by adding new "SOP Classes"**
  - **<u>New SOP Classes are added</u>**
  - **<u>Old SOP Classes don't "break"</u>**
  - **Most applications continue to support older SOP Classes when supporting new ones**

Stability and <u>Maintenance</u>

- ## Don't break existing implementations

  In <u>existing</u> SOP Classes:

  - Clarify but don't change meaning

  - Add new codes, attributes, or behaviors BUT products don't have to support them and can ignore them safely.

  - Exception: fix something that is already broken

- ## The Caveat

  - Vendors are still responsible to monitor CPs and fix their products when they are deficient

Publication vs Conformance

- **DICOM Conformance is to SOP Classes**
  - *not to a version of the Standard*

- **New DICOM editions are published (e.g. 2018c)**
  - **SOP Classes are added but not changed incompatibly**

- **Each SOP Class is stable**
  - **forward and backward compatible across all editions**
  - **any data elements added are optional**

- **Products conforming to the same SOP Class interoperate**
  - **Humans compare DICOM Conformance Statements (DCS)**
  - **Machines do Association Negotiation**

DICOM Conformance Statement

- **Required for every compliant product – *pro-forma* in DICOM Part 2**

- **Lists the SOP Classes / roles supported by a product**

- **Allows user organization (system integrator) to determine components that should work together**

- **Describes product implementation details and behaviors**
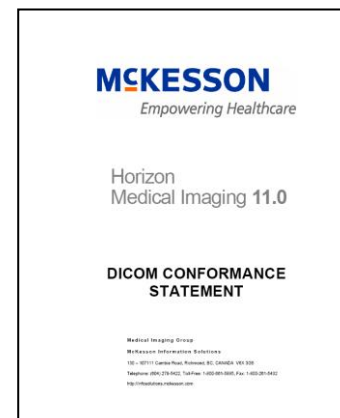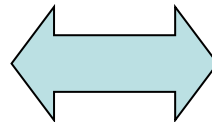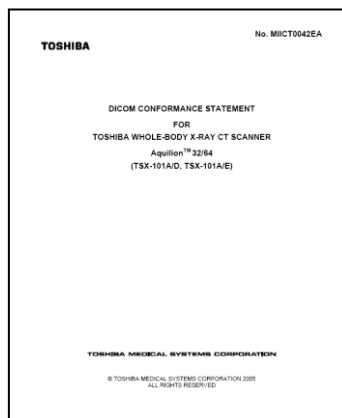
Machine Negotiation
of Conformant Capabilities

Before two systems perform a DICOM transaction they first agree:

- **what SOP Class they will use (e.g. MR Image Storage)**
- **who will be the SCU (client role), who will be the SCP (server role)**
- **what compression will be used (e.g. JPEG Lossless)**

This process is called Association Negotiation

AE_TITLE1

Association Negotiation

<Request>

<Response>

MR Image Storage

AE_TITLE2
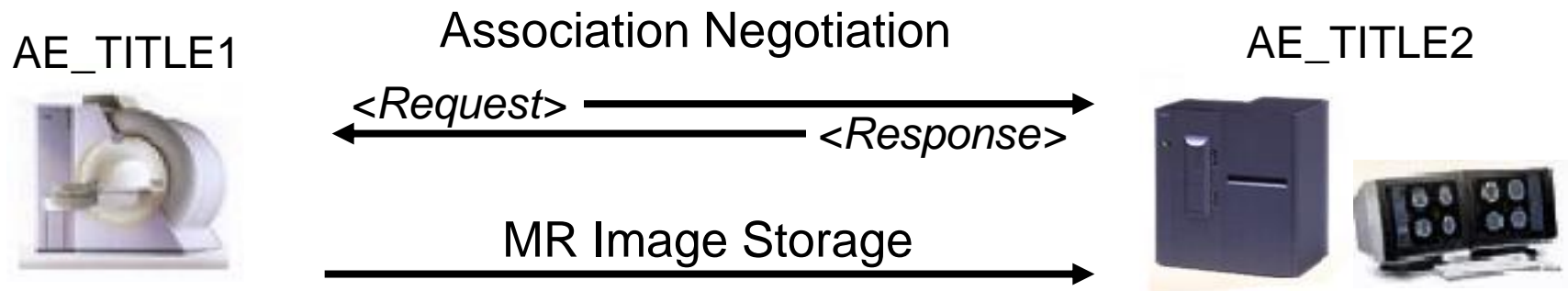
Information Model Stability
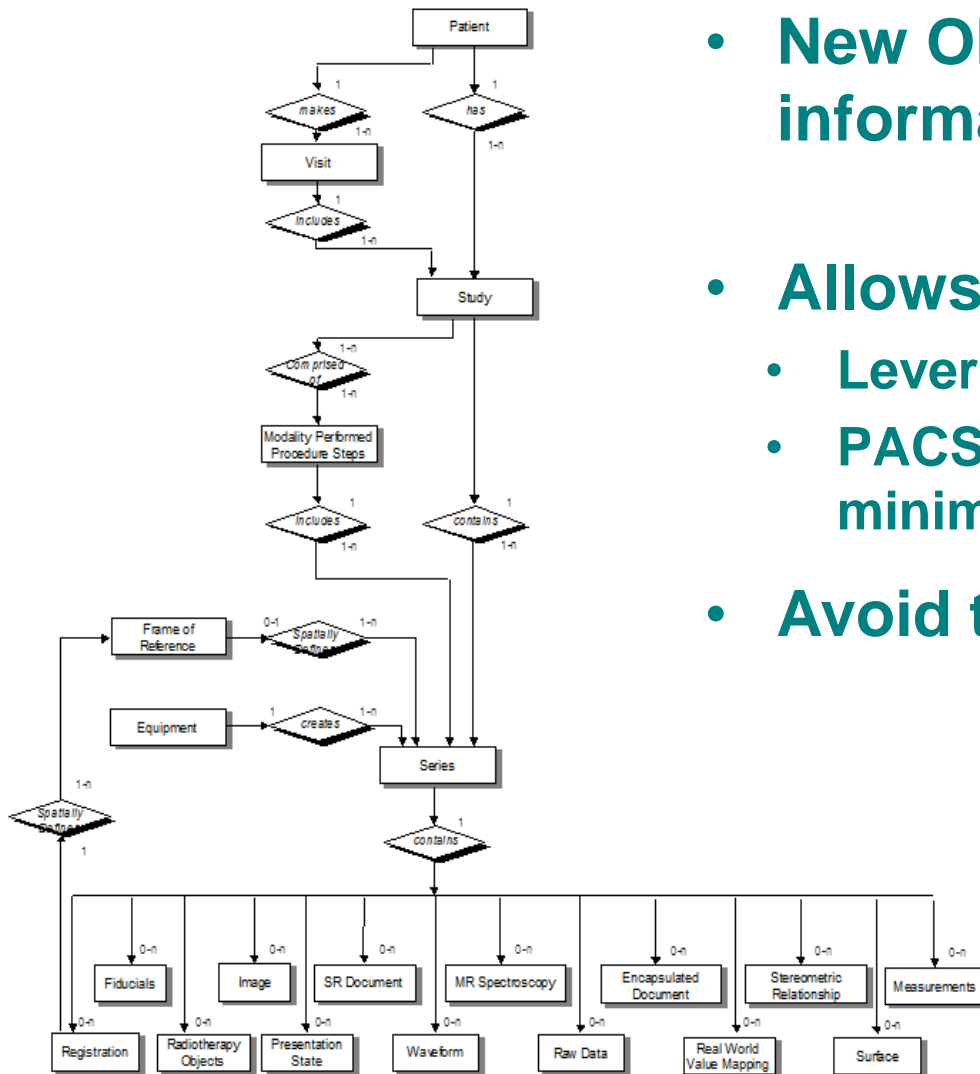
- **New Objects conform to existing information/real-world model**

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

- **Avoid temptation to "improve"**

The Information Model

Simplified model of real world concepts and activities

- **Study ≈ ordered procedure; Series ≈ performed protocol**
- **Sufficient for pragmatic needs of routine radiology**

DICOM Model Elements
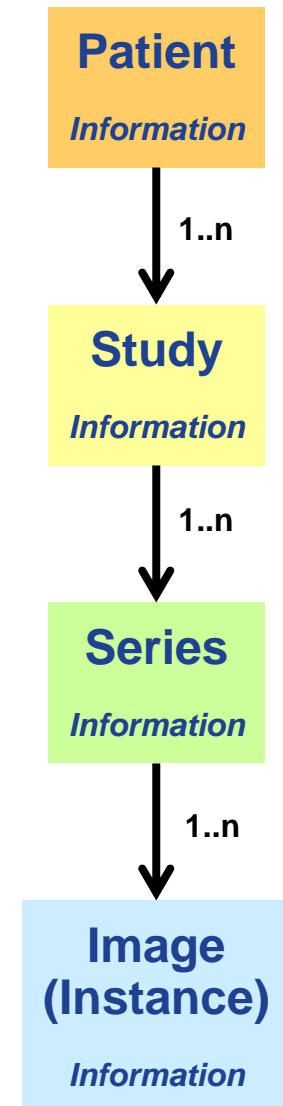
An __Image__ (or other IODs) holds acquired data

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 (__UID__s) to identify:

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

Starting from the bottom ...

MR Storage SOP Class

Service Class User

Storage Service

+

MR Object

Service Class Provider

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

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)

XML / Web publication

- **DICOM Standard is maintained in DocBook XML and published <u>free</u> 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://dicomstandard.org/current
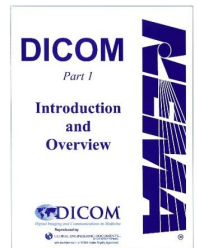
The DICOM Standard

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 <u>free</u> electronic copies of all 20 Parts of the Standard**
- **Plans and activities are publicly posted**
- **ISO publishes Part 1 of the Standard as ISO 12052**

Participate !

- **DICOM invites new members & contributors**
  - **Application process**
  - **Patent disclosure policy**
  - **dicomstandard.org**
  - **dicom@dicomstandard.org**

- **Great opportunity to learn**

- **Great opportunity to contribute**

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Thank you for your attention !

DICOM Educational Conference
Brisbane, Australia

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WHAT IS A SECRETARIAT AND WHAT DOES IT DO?

MEDICAL IMAGING TECHNOLOGY ASSOCIATION (MITA)

LISA SPELLMAN,
DICOM GENERAL SECRETARY

DICOM Secretariat

About

- Staff

- Operations and strategy

- Member services

- Collaboration and participation

Current initiatives

- Expanded DICOM communications & outreach with DICOM WG-29

- Infrastructure review

- Tell us! Share your questions and stories

  - Cool things about DICOM you never knew (but should)

  - Member profile spotlight

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Medical Imaging Technology Association (MITA)

- Is a division of the National Electrical Manufacturers Association (NEMA)

- Collective voice of manufacturers, innovators, and product developers in medical imaging and radiopharmaceuticals

- Represents companies whose sales make up more than 90 percent of the global market for advanced imaging technologies

- MITA hosts DICOM Secretariat

2018 initiatives include:

➢ Adopt Uniform Standards for Medical Imaging Service Providers

➢ Ensure Patient Access to Medical Imaging

➢ Promote Cybersecurity for Medical Imaging

➢ Improve Regulatory Environment to Promote Growth and Innovation

➢ Remove Barriers and Reduce Costs in Markets Worldwide

Thank you!

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Secretariat Resource Links

DICOM Secretariat General Mailbox: **dicom@dicomstandard.org**
DICOM Website: **www.dicomstandard.org**
MITA Website: **www.medicalimaging.org**
NEMA Website: **www.nema.org**

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