RADIOLOGY RESEARCH

DICOM Enhancements

Current and Future

Donald Peck, PhD
Michael Flynn, PhD

Parts I & II

2

Part I

An overview of the DICOM standard

- Parts of the standard
- The concept of objects
- Implementation of changes

Part II

Example enhancements and work items

- Recent enhancements
- Current work items

AAPM 2007

Dicom Standard

3

- Developed with an emphasis on diagnostic medical imaging as practiced in radiology, cardiology and related disciplines
  - Also applicable to a range of image and non-image information exchanged in other medical environments
- Specification of strict requirements for the contents of the image "header"

AAPM 2007

Dicom Standard

4

- Utilizes an open standards development process that encourages the involvement and consensus of both vendors and users
- Specification of a conformance mechanism so that a user can decide whether or not devices are likely to interoperate

AAPM 2007

DICOM Functionality

5

- Transmission and persistence of objects
  - images, waveforms and documents
- Query and retrieval of objects
- Performance of specific actions
  - Example: printing images onto film

AAPM 2007

DICOM Functionality

6

- Workflow management
  - support of worklists and status information
- Quality and consistency of data
  - Example: display and printing of images

AAPM 2007

DICOM Standards Committee (DSC)

7

- DICOM's executive body whose members are imaging equipment manufacturers, physician organizations, and others
  - 26 manufacturer members
  - 20 other members
- DICOM's activities are coordinated through a general secretariat at NEMA

AAPM 2007

DICOM Standards Committee (DSC)

8

- Development of DICOM Standard is done through committees termed "Working Groups" (WG)
- WG propose work items based on suggestions from members or at the direction of the DSC

AAPM 2007

WG#	Working Group Name	Relevance to Radiology
1	Cardiac and Vascular Information	Cardiovascular imaging, stress nuclear cardiology structured reporting
2	Projection Radiography and Angiography	Development of enhanced x-ray and angiography information objects
3	Nuclear Medicine	Nuclear medicine and PET
4	Compression	Application of data compression standards, such as JPEG 2000 and JPIP
5**	Exchange Media	Distribution of images on CD-ROMs, DVDs, and USB "flash" drives
6	Base Standard	Detailed technical evaluation of proposed additions or changes to the DICOM standard

** Not currently active

WG#	Working Group Name	Relevance to Radiology
7	Radiotherapy	Radiation therapy, including ion therapy
8	Structured Reporting	Standardized vocabularies, encoding of structured reports, and integration with
10	Strategic Advisory	Long-range planning; coordination of DICOM with other international standards organizations
11	Display Function Standard	Presentation and display of images on workstations, i.e., "hanging protocols."
12	Ultrasound	Ultrasound imaging, including echocardiography; 3D/4D images

WG#	Working Group Name	Relevance to Radiology
14	Security	Secure information exchange
15	Digital Mammography and CAD	Breast imaging; structured reporting of computed-aided detection and diagnosis (CAD) results for mammography and CT colonography
16	Magnetic Resonance	MRI
17	3D	Volumetric (multiframe) imaging modalities, including CT, MR, and ultrasound
18*	Clinical Trials and Education	Application of imaging to clinical trials and medical education

* starting activity

WG#	Working Group Name	Relevance to Radiology
19**	Dermatology Standards	Dermatology
20	Integration of Imaging and Information Systems	Coordination of DICOM with Health Level Seven (HL7) standard for messaging between health information systems
21**	Computed Tomography	CT imaging and dosimetry reporting
22	Dentistry	Dentistry
23	Application Hosting	Develop specifications for interfaces between hosted application software
24	DICOM in Surgery	Image-guided surgery and other surgical data
25**	Veterinary Applications	Veterinary
26	Pathology	Pathology Applications

** Not currently active

DICOM "workflow"

13

- Work items are divided into Supplements and Change Orders
  - Supplements define new objects, content or structure
  - Change Orders modify the existing Standard

AAPM 2007

DICOM "workflow"

14

- Output of a work item is submitted to the Base Standards Working Group (WG6) for review
  - WG6 may request changes or clarification to work item to ensure it complies with Standard
- Once all issues are satisfied WG6 petitions the DSC to approve work item and send out for public comment

AAPM 2007

DICOM "workflow"

15

- After public comment the DSC authorizes the work item for letter ballot by DICOM members
- Change proposals are often "batched" for public comment and letter ballot, but can be instituted without comment or ballot if the change is required to reduce potential patient care issues or it is typographical or trivial in nature

AAPM 2007

Changes to Standard

16

- Currently 100 approved Supplements incorporated into Standard
  - Another 25 in progress or in comment stage
- Currently ~600 Change Proposals incorporated into Standard
  - ~100 additional in progress

AAPM 2007

17

Currently 16 parts

Describes how the Standard is organized

- PS 3.1 Introduction and Overview
- PS 3.2 Conformance
- PS 3.3 Information Object Definitions
- PS 3.4 Service Class Specifications
- PS 3.5 Data Structures and Encoding
- PS 3.6 Data Dictionary
- PS 3.7 Message Exchange
- PS 3.8 Network Communication Support for Message Exchange
- PS 3.10 Media Storage and File Format for Data Interchange
- PS 3.11 Media Storage Application Profiles
- PS 3.12 Media Formats and Physical Media for Data Interchange
- PS 3.14 Grayscale Standard Display Function
- PS 3.15 Security Profiles
- PS 3.16 Content Mapping Resource
- PS 3.17 Explanatory Information
- PS 3.18 Web Access to DICOM Persistent Objects (WADO)

AAPM 2007

18

DICOM Standard

- PS 3.3 Information Object Definitions (IOD)
  - Description of an object's purpose and the Attributes which define it
- PS 3.4 Service Class Specifications
  - Associates one or more Information Object with one or more Commands to be performed upon these objects
    - Examples:
      - Storage
      - Query/Retrieve
      - Worklist Management
      - Print Management

AAPM 2007

19

DICOM Standard

- PS 3.5 Data Structures and Encoding
  - Specifies how applications construct and encode the Data Set
- PS 3.6 Data Dictionary
  - Centralized registry which defines the collection of all DICOM Data Elements

AAPM 2007

20

DICOM Standard

- PS 3.7 Message Exchange
  - Specifies the service and protocol used by an application in a medical imaging environment to exchange Messages over the communications support services defined in PS 3.8
- PS 3.8 Network Communication Support for Message Exchange
  - Specifies the communication services and the upper layer protocols necessary to support communication between DICOM applications

AAPM 2007

21

DICOM Standard

- PS 3.10 Media Storage and File Format for Data Interchange
- PS 3.11 Media Storage Application Profiles
- PS 3.12 Media Formats and Physical Media for Data Interchange

AAPM 2007

22

DICOM Standard

- PS 3.14 Grayscale Standard Display Function
  - Specifies a standardized display function for grayscale images
- PS 3.15 Security Profiles
  - Specifies security and system management profiles
- PS 3.16 Content Mapping Resource
  - templates for structuring documents and a lexicon of terms defined

AAPM 2007

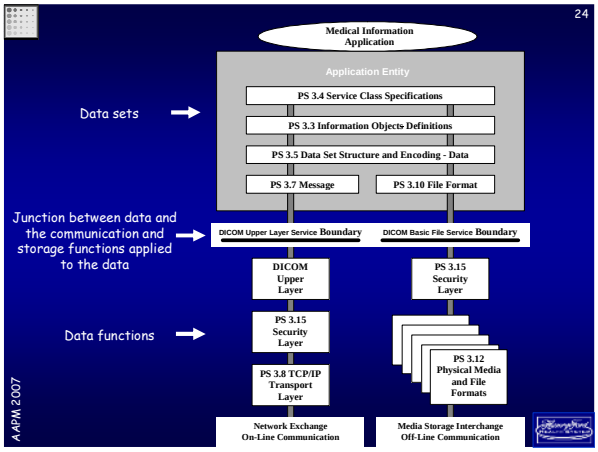
23

DICOM Standard

- PS 3.17 Explanatory Information
  - Informative and normative annexes containing explanatory information about most IOD
- PS 3.18 Web Access to DICOM Persistent Objects (WADO)
  - Specifies the means whereby a request for access to a DICOM persistent object can be expressed as an HTTP URL/URI request that includes a pointer to a specific Instance UID

AAPM 2007

24



AAPM 2007

How to "read" DICOM Objects

25

- Attributes describe the properties of a Information Object
  - Related attributes are grouped into Modules
  - Sets of attributes can be referenced by Macros within Modules

Example Module Table

Attribute Name	Tag	Type	Attribute Description
Attribute A	(aaaa,aaaa)	1	This is an example.
Attribute B Sequence	(bbbb,bbbb)	1	This is an example of a Sequence Attribute
>Include 'Example Macro' Table 5.4-2			*In this Module, Attribute D (dddd,dddd) is Type 1*

How to "read" DICOM Objects

26

- Data Element Tag is a unique identifier for the attribute
  - First 4 digits = Group Number
  - Second 4 digits = Element Number
  - Data elements defined by the Standard have an even group number
  - Private data elements have an odd group number
    - Standard does not define any Private Tag attributes
  - Tag is a hexadecimal number

Example Module Table

Attribute Name	Tag	Type	Attribute Description
Attribute A	(aaaa,aaaa)	1	This is an example.
Attribute B Sequence	(bbbb,bbbb)	1	This is an example of a Sequence Attribute
>Include 'Example Macro' Table 5.4-2			*In this Module, Attribute D (dddd,dddd) is Type 1*

How to "read" DICOM Objects

27

- Data Element Type defines whether an attribute is required
  - Type 1 = mandatory attribute that must always be included
  - Type 2 = mandatory attribute that must be included if known
  - Type 3 = optional attribute
- In some instances attribute may be conditional based on specified criteria, in these cases type # is followed by a "C"
  - i.e. Type 1C, 2C or 3C
- Value Representation (VR) for each attribute is given in PS 3.6 Data Dictionary – Registry of Data DICOM elements

DICOM Attribute Example

28

Table 10-10
BASIC PIXEL SPACING CALIBRATION MACRO ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Pixel Spacing	(0018,0030)	1C	Physical distance in the patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See 10.7.1.1 and 10.7.1.3.
Pixel Spacing Calibration Type	(0028,0402)	3	The type of correction for the effect of geometric magnification or calibration against an object of known size. Enumerated Values: See 10.7.1.2.
Pixel Spacing Calibration Description	(0028,0404)	1C	A free text description of the type of correction or calibration performed. Notes: 1. In the case of correction, the text might include description of the assumptions made about the body part and geometry and depth within the patient. 2. In the case of calibration, the text might include a description of the fiducial and where it is located (e.g., "XYZ device applied to the skin over the greater trochanter"). 3. Though it is not required, the Device Module may be used to describe the specific characteristics of the calibration device. Required if Pixel Spacing Calibration Type (0028,0402) is present.

Pixel Spacing attributes

29

- Pixel spacing attributes are encoded as the physical distance between centers of 2D pixel
- This description applies to:
  - Pixel Spacing (0028,0030)
  - Imager Pixel Spacing (0018,1164)
  - Nominal Scanned Pixel Spacing (0018,2010)
  - Image Plane Pixel Spacing (3002,0011)
  - Compensator Pixel Spacing (300A,00E9)
  - Detector Element Spacing (0018,7022)
  - Presentation Pixel Spacing (0070,0101)
  - Printer Pixel Spacing (2010,0376)
  - Object Pixel Spacing in Center of Beam (0018,9404)

DICOM Attribute Example

30

Table C.8-71
DX DETECTOR MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Include 'Digital X-Ray Detector Macro' Table C.8-71h			
Imager Pixel Spacing	(0018,1164)	1	Physical distance measured at the front plane of the detector housing between the center of each image pixel specified by a numeric pair - row spacing value (delimiter) column spacing value in mm. See 10.7.1.3 for further explanation of the value order. The value of this attribute shall never be adjusted to account for corrections for the effect of geometric magnification or calibration against an object of known size. Pixel Spacing (0028,0030) is specified for that purpose.
Include 'Basic Pixel Spacing Calibration Macro' (Table 10-10)			

DICOM Attribute Example

31

Table C.8-71h
DIGITAL X-RAY DETECTOR MACRO ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Detector Binning	(0018,701A)	3	Number of active detectors used to generate a single pixel. Specified as number of row detectors per pixel then column.
Detector Element Physical Size	(0018,7020)	3	Physical dimensions of each detector element that comprises the detector matrix, in mm. Expressed as row dimension followed by column. Note: This may not be the same as Detector Element Spacing (0018,7022) due to the presence of shielding material between detector elements.
Detector Element Spacing	(0018,7022)	3	Physical distance between the center of each detector element, specified by a numeric pair - row spacing value (delimiter) column spacing value in mm. See 10.7.1.3 for further explanation of the value order. Note: This may not be the same as the Imager Pixel Spacing (0018,1164), and should not be assumed to describe the stored image.

IOD tables of Modules

- Information for each module includes:
  - IE = Information entity
  - Module name
  - Reference to Section in Annex C that contains the Module
  - Usage Code
    - M = module support is mandatory
    - C = module support is conditional based on specified criteria
    - U = module support is optional based on the user

Table A.26-1
DIGITAL X-RAY IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Specimen Identification	C.7.1.3	U
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	DX Series	C.8.11.1	M
	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Plane	C.7.6.2	M
	Contrast/Bolus	C.7.6.4	U
	Display Shutter	C.7.6.14	U
	Device	C.7.6.15	U
	Intervention	C.7.6.16	U
	DX Anatomy Imaged	C.8.11.2	M
	DX Image	C.8.11.3	M
	DX Detector	C.8.11.4	M
	X-Ray Dose	C.8.7.3	U
	DX Positioning	C.8.11.5	U
	X-Ray Tube Acquisition	C.8.7.2	U
	X-Ray Accumulation Dose	C.8.7.8	U
	X-Ray Generation	C.8.7.9	U
	X-Ray Filtration	C.8.7.10	U
	X-Ray Grid	C.8.7.11	U
	Overlay Plane	C.9.2	C - Required if possible, innovation is present - See A.26.1
	VOI LUT	C.11.2	C - Required if Presentation Intent Type (0008,0068) is FOR PRESENTATION. Shall not be present otherwise. See Note 6
	Image Histogram	C.11.5	U
	Acquisition Context	C.7.6.14	M
	SOP Common	C.12.1	M

Changes to the Standard

33

On a yearly basis all changes to the Standard are published at: http://medical.nema.org/dicom/

AAPM 2007

Parts I & II

34

Part I

An overview of the DICOM standard

- Parts of the standard
- The concept of objects
- Implementation of changes

Part II

Example enhancements and work items

- Recent enhancements
- Current work items

AAPM 2007

Recent DICOM Enhancements

35

- WG04 (Compression)
  - JPEG 2000 Interactive Protocol
- WG16 (MR)
  - Multiframe MR Object
- WG21 (CT)
  - Enhanced CT Image Storage SOP Class
  - CT Radiation Dose Reporting
- WG17 (3D)
  - Segmentation Storage SOP Class
  - Deformable Spatial Registration Storage SOP Class

AAPM 2007

New DICOM work items

36

- WG3 (NM)
  - Enhanced PET Image Storage SOP Class
- WG7 (RT)
  - Enhanced RT Object
- WG15 (Digital Mammography)
  - Breast Tomosynthesis Image Storage SOP Class
- WG17 (3D)
  - Surface Segmentation Storage SOP Class

AAPM 2007

1 - JPIP: WG 4, Supplement 106

37

JPEG 2000 Interactive Protocol

- Working Group 4 : Supplement 106
- Final Text, January 26, 2006

"This Supplement extends the Pixel Data Module to allow reference to a JPIP URL to access pixel data, rather than encoding it in the image instance…The use cases for this extension to the standard relate to an application's desire to gain access to a portion of DICOM pixel data without the need to wait for reception of all the pixel data. Examples are:

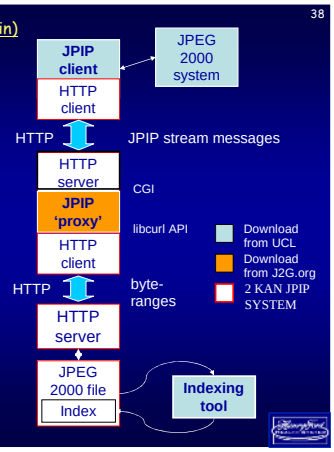
1) Stack Navigation of a large CT Study.
2) Large Single Image Navigation
3) Thumbnails
4) Display by Dimension

AAPM 2007

1 - JPIP: 2KAN (Public Domain)

38

JPIP is a client/server communication protocol defined in Part 9 of the JPEG 2000 suite of standards



www.2kan.org

2KAN is an EC IST project

AAPM 2007

1 - JPIP: Kakadu

39

www.kakadusoftware.com

- Kakadu is a complete implementation of the JPEG2000 standard (p1)
- The Kakadu software is written by
  - David Taubman,
  - Prof. Univ. S. Wales,

  who was also the principle author of the JPEG2000 Verification Model (VM) software.
- Minimal license fee for the development of JPEG2000 "freeware".

AAPM 2007

1 - JPIP: Tag (0028,7FE0)

40

Supplement 106 establishes a JPIP transfer syntax and adds a tag that provides a URL to the image data that is used instead of the traditional pixel data tag (7FE0,0010).

Table C.7-11a
IMAGE PIXEL MODULE ATTRIBUTES

Pixel Data Provider URL	(0028,7FE0)	1C	A URL of a provider service that supplies the pixel data of the Image. Required if the Image is to be transferred in one of the following presentation contexts identified by Transfer Syntax UID: 1.2.840.10008.1.2.4.94 (DICOM JPIP Referenced Transfer Syntax) 1.2.840.10008.1.2.4.95 (DICOM JPIP Referenced Deflate Transfer Syntax)

AAPM 2007

41

1 - JPIP: Informative Annex

Annex X
JPIP Referenced Pixel Data
Transfer Syntax Negotiation

Case 1: AE1 and AE2 both support both a JPIP Referenced Pixel Data Transfer Syntax and a non-JPIP Transfer Syntax

- AE1
  makes a C-MOVE request to AE2
- AE2
  proposes two presentation contexts to AE1, one for with a JPIP Referenced Pixel Data Transfer Syntax, and the other with a non-JPIP Transfer Syntax
- AE1
  accepts both presentation contexts
- AE2
  may choose either presentation context to send the object
- AE1
  must be able to either receive the pixel data in the C-STORE message, or obtain it from the provider URL

AAPM 2007

42

1 - JPIP: Proprietary Implementations

- Many PACS systems provide services for client access to images using proprietary progressive streaming technology.
- DICOM JPIP provides a standardized method that might have particular use in an open-source application.
- Possible intellectual property issues still exist.

US 6,556,724 B1
Apr. 29, 2003
Chang, Huffman, Hebert (Univ. of Pttsburgh) Assignee: Stentor
… The source image is transformed into a hierarchical representation, such that each level of the hierarchical representation is sufficient to reconstruct the source image at a given resolution. …

AAPM 2007

43

2 - eMR: WG 16, Supplement 49

Enhanced MR Image Storage SOP Class

- Working Group 16 : Supplement 49
- Final Text, 26 March, 2002

"The supplement describes 3 new IODs:

1. Enhanced MR Image
2. MR Spectroscopy
3. Raw Data

"A Multi-Frame concept is introduced which allows attributes grouped together to vary on a frame by frame base. This method is modality independent.

AAPM 2007

44

2 - eMR: Multiframe

24 Dynamic Functional Groups

Pixel Measures	MR Image Frame Type
Frame Content	MR Timing & Related Parameters
Plane Position	MR FOV/Geometry
Plane Orientation	MR Echo
Referenced Image	MR Modifier
Derivation Image	MR Image Modifier
Cardiac Trigger	MR Receive Coil
Frame Anatomy	MR Transmit Coil
Pixel value Transformation	MR Diffusion
Frame VOI LUT	MR Averages
Real World Value Mapping	MR Spatial Saturation
	MR Metabolite Map
	MR Velocity Encoding

From Charles Parisot , May 5, 2002, Korean PACS Conference

AAPM 2007

2 - eMR: Multiframe

45

24 Dynamic Functional Groups

For a Specific MR Image Instance :
- some Functional Groups are shared across all frames,
- some vary per frame

Pixel Measures	MR Image Frame Type
Frame Content	MR Timing & Related Parameters
Plane Position	MR FOV/Geometry
Plane Orientation	MR Echo
Referenced Image	MR Modifier
Derivation Image	MR Image Modifier
Cardiac Trigger	MR Receive Coil
Frame Anatomy	MR Transmit Coil
Pixel value Transformation	MR Diffusion
Frame VOI LUT	MR Averages
Real World Value Mapping	MR Spatial Saturation
	MR Metabolite Map
	MR Velocity Encoding

MR Image Instance

Shared Functional Groups

Attributes For all frames

Per Frame Functional Group Sequence

Frame 1 attributes

Frame 2 attributes

A APM 2007

From Charles Parisot , May 5, 2002, Korean PACS Conference

2 - eMR: Image Description Macro

46

- MR has a large, rich set of image types
- Applications need a way to determine if an image set is compatible with its processing
- Supplement 49 proposes a reasonably orthogonal set of attributes for image type useful to reading applications:
- Image Type (0008,0008) values:
  - 1: Original/Derived – redefined
  - 2: Primary/Secondary – Only Primary valid for MR
  - 3: Image Flavor – the overall most important characteristic of this Image – e.g. flow encoded, max-IP, Perfussion, Stress, T1, T2, etc.
  - 4: Derived Contrast – Diffusion aniso, Subtraction, Velocity, None – generally an indication of post processing performed

A APM 2007

From Charles Parisot , May 5, 2002, Korean PACS Conference

2 - eMR: Image Description Macro

47

- Other Image Types are separate attributes:
  - Pixel Presentation

    (Palette) Color/Monochrome (color supported or not)
  - Volumetric Properties

    Volume, Sampled, Distorted (used by Grx, 3D to determine image compatibility with the application)
  - Volume Based Calculation Technique

    MAX_IP, MPR, Curved-MPR… (used by Grx, 3D to determine image compatibility)
  - Complex Image Component

    Magnitude, Phase, Real, Imaginary (standard MR transformations of the raw data)
  - Acquisition Contrast

    T1, T2, Perfusion, Combination… (MR acquisition contrast types)

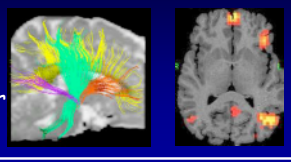
A APM 2007

From Charles Parisot , May 5, 2002, Korean PACS Conference

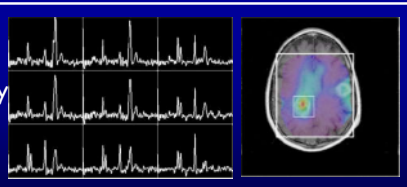
2 - eMR: color, spectroscopy

48

Color



Spectroscopy



A APM 2007

From David Clunie , May 22, 2004, SCAR Hot Topics

49

2 - eMR: mandatory tags

A large percent of the new tags in the enhanced MR object are mandatory and are those in the enhanced CT object.

	CT		MR	
SOP Class	Original	Enhanced	Original	Enhanced
Attributes (Mandatory)	18 (0)	41 (39)	44 (2)	103 (94)
Terms (Enumerated)	4 (2)	86 (18)	38 (9)	228 (47)

From David Clunie , May 22, 2004, SCAR Hot Topics

AAPM 2007

50

3 - eCT: WG 21, Supplement 58

Enhanced CT Image Storage SOP Class

- Working Group 21 : Supplement 58
- Final Text, January 14, 2004
  (Amended July 5, 2004)

".. it is necessary to create a new CT object to meet the needs of state of the art CT technology that has evolved substantially since the existing CT object was standardized in 1993."

"Furthermore, new applications such as cardiac CT, gated studies, perfusion CT, CT fluoroscopy, contrast tracking and post-processing are not supported by the current standard. ..."

AAPM 2007

51

3 - eCT: Spiral Pitch

4 mandatory tags in the CT table Dynamics Macro are unambiguously defined in an informative paragraph .

C.8.15.3.4.1 Spiral Pitch Factor

The formula for Spiral Pitch Factor (0018,9311) in terms of Table Feed per Rotation (0018,9310) and Total Collimation Width (0018,9307) is:

Spiral Pitch Factor = (Table Feed per Rotation (mm)) / (Total Collimation Width (mm))

An example calculation of Spiral Pitch Factor (0018,9311) for a single slice spiral acquisition of an image with a Total Collimation Width of 2.5mm and a Table Feed per Rotation of 10mm is:

Spiral Pitch Factor = (10 mm)/(2.5 mm) = 4.0

An example calculation of Spiral Pitch Factor (0018,9311) for a multiple slice spiral acquisition having a Total Collimation Width of 20mm and a Table Feed per Rotation of 10mm is:

Spiral Pitch Factor = (10 mm)/(20 mm) = 0.5

AAPM 2007

52

3 - eCT: Acquisition Type

The Acquisition Type (0008,9303) contains a description of the method used during acquisition of the frame from a list of defined terms .

C.8.15.3.2.1 Acquisition Type

Acquisition Type (0018,9302) has the following Defined Terms:

- SEQUENCED identifies that the acquisition was performed by acquiring single or multi detector data while rotating the source about the gantry while the table is not moving. Additional slices are acquired by incrementing the table position and again rotating the source about the gantry while the table is not moving.
- SPIRAL identifies that the acquisition was performed by acquiring data while rotating the source about the gantry while continuously moving the table.
- CONSTANT_ANGLE identifies that the acquisition was performed by holding the source at a constant angle and moving the table to obtain a projection image (e.g., a localizer image).
- STATIONARY identifies that the acquisition was performed by holding the table at a constant position and acquiring multiple slices over time at the same location.
- FREE identifies that the acquisition was performed while rotating the source about the gantry while the table movement is under direct control of a human operator or under the control of an analysis application (e.g., fluoroscopic image).

AAPM 2007

53

3 - eCT: Dynamic Contrast

- Conventional hanging protocols are rarely sophisticated enough to recognize multiple phases of contrast enhancement, e.g., during CT of liver
- Old DICOM objects have no standard information about contrast phase
- New objects name phases of contrast administration for each frame

PRE-CONTRAST, POST-CONTRAST, IMMEDIATE, DYNAMIC, STEADY-STATE, DELAYED, ARTERIAL, CAPILLARY, VENOUS, PORTAL-VENOUS

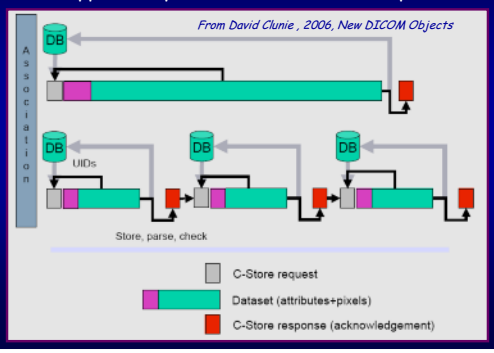
From David Clunie , 2006, New DICOM Objects

AAPM 2007

54

3 - eCT: Multi Frame Performance

- Reduced communication latency (delay)
- Opportunity for inter-slice (3D) compression



AAPM 2007

55

3 - eMR & eCT conformance

SOP Class UIDs

- Enhanced CT 1.2.840.10008.5.1.4.1.1.2.1
- Enhanced MT 1.2.840.10008.5.1.4.1.1.4.1

AAPM 2007

56

4 - ePET: WG 3, Supplement 117

Enhanced PET Image Storage SOP Class

- Working Group 3 : Supplement 117
- Letter Ballot, June 7, 2007

"This Supplement describes the Enhanced Positron Emission Tomography Storage SOP Class, which allows the PET Image generating system to store information on systems, which perform as a PET Storage SCP.

The old concept of the Standalone PET Curve is not retained as a part of this new IOD. A new work item could be to investigate a more general method for encoding time/intensity information, but this is outside the scope of this document."

AAPM 2007

57

5 - x3D: WG 2, 15, 22, Supplement 116

X-Ray 3D Storage SOP Class

- Working Groups 2, 15 22
- Supplement 116
- Final Text, 23 January 2007

"This supplement to the DICOM standard introduces the new X-Ray 3D Storage SOP Classes. It is based on the new multi-frame concepts, introduced with the enhanced MR SOP Classes."

X-Ray 3D Angiographic Image SOP Class
X-Ray 3D Craniofacial Image SOP Class

AAPM 2007

58

5 - x3D: Scope

Scope:

The scope of this Supplement is defining a baseline for a family of dedicated X-Ray multi-dimensional storage SOP Classes that would define the 3D volume or volumes created from X-Ray cone beam projection.

Cartesian:

The slices of the volumes are in the Cartesian format, i.e., non-curved slices defined by position and orientation properties.

AAPM 2007

59

5 - x3D: SOP classes

The X-Ray 3D Angiographic Image SOP Class allows storage of the results of a 3D reconstruction from either the current XA SOP Class images or the new Enhanced XA SOP Class. The X-Ray 3D Angiographic Image SOP Class definition will include the relationship to the isocenter reference system and the relevant acquisition attributes from 2D projection images.

The X-Ray 3D Craniofacial Image SOP Class allows storage of the results of a 3D reconstruction from the current SOP Class images used in dentistry. The X-Ray 3D Craniofacial Image SOP Class definition will include the relationship to the isocenter reference system and the relevant acquisition attributes from 2D projection images.

AAPM 2007

60

5 - x3D: Breast Tomosynthesis

- Supplement 125
- Public Comment – 29 March 2007

"The scope of this Supplement is to customize the X-Ray multi-dimensional storage SOP Class .. to define the 3D volume or volumes created from digital breast tomosynthesis x-ray projections."

AAPM 2007

5 - x3D: brTS open issues

61

..

7 How should we describe the "cumulative" organ dose for all source projections of a view?

..

10 Are the per projection attributes in the Breast Tomosynthesis Acquisition Sequence sufficient for source image quality evaluation by physicists? Are all of the listed attributes necessary to include?

..

11 Can the Focal Spot of the source projections change per projection, or is it the same for all source projections?

AAPM 2007

6 – 3D: WG 17, Supplement1 111

62

Segmentation Storage SOP Class

- Working Group 21
- Supplement 111
- Final Text – August 22, 2006

"The domain of this Supplement is segmentation instances created during acquisition, postprocessing, interpretation and treatment.

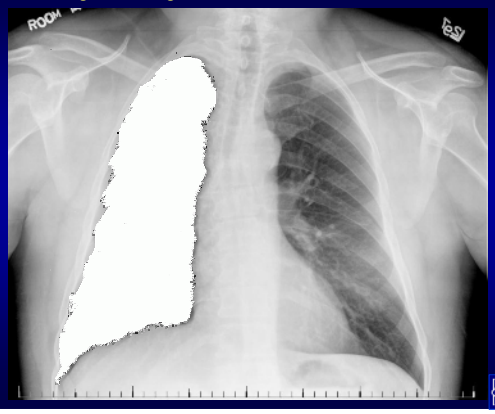
A growing number of applications perform segmentations and work with the resulting segments for which there is no widely used representation within DICOM.

The Supplement provides a way to encode segmentation data. It is intended for composite data objects of any modality or clinical specialty."

AAPM 2007

6 – 3D: Segmented regions

63



AAPM 2007

6 – 3D: WG 17, Supplement 111

64

Polygonal Segmentation Storage SOP Class

- Working Group 21
- Supplement 132
- Draft .8 – June 5, 2007

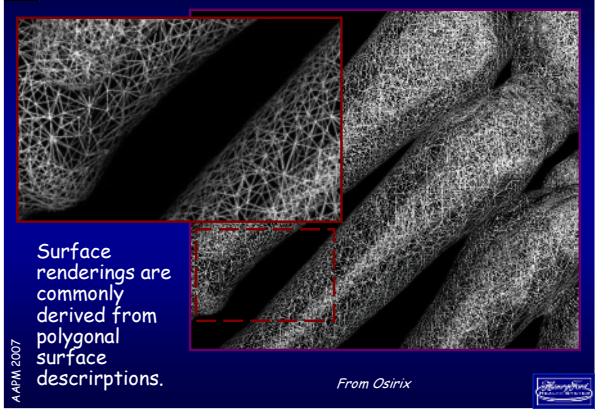
"*The domain of this Supplement is … [from sup111]*

The Supplement contains a new Common Surface Mesh Module that is used do encode the segmentation data. It is intended for composite data objects of any modality or clinical specialty.

AAPM 2007

6 – 3D: polygons

65



Surface renderings are commonly derived from polygonal surface descrirptions.

From Osirix

AAPM 2007

Comment

66

- In the coming year, it is anticipated that the AAPM will apply to become a member organization of the DICOM Standards Committee.
- Members are being solicitated for participation in specific working groups that are closely aligned with Medical Physics.

AAPM 2007

Questions?

67

?

AAPM 2007