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Digital Imaging and Communications in Medicine (DICOM)

Supplement 252: For Processing CT SOP Classes

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Scope and Field of Application

This Supplement adds For Processing storage SOP Classes based on the existing CT Image IOD, Enhanced CT Image IOD, and Legacy Converted Enhanced CT Image IOD.

For Processing storage SOP Classes in DICOM facilitate the exchange and storage of images needed for processing while distinguishing them from those for presentation. This supports appropriate data pipelines while not disrupting reading workflow with images not intended for presentation.

These new SOP Classes mirror existing Mammography, Intra-Oral X-ray, and Digital X-ray For Processing SOP Classes.

One application of the For Processing SOP Classes is to store and exchange CT basis images created by the multi-energy decomposition process. These are not typically diagnostic themselves, but can be processed to generate an extensive variety of diagnostic images (iodine maps, virtual non-contrast images, virtual monoenergetic images at various energy levels, calcium maps, etc.). Hanging Protocols would typically ignore these For Processing images.

Open Issues:

Q1. Are there attributes in the CT Image IOD which it would be useful to make Type 1C / 2C (conditional on the Presentation Intent Type being FOR PROCESSING) in the new For Processing SOP Classes?

E.g. are there details that would be valuable for Multi-Energy that needed to stay Type 3 in the existing CT Image SOP Classes to avoid breaking implementations?

Q2. Should one of the existing general codes in CID 7202 be used instead of the proposed Basis code.

E.g could use (121322, DCM, Source image for image processing operation) or (121358, DCM, For Processing predecessor). That would involve using some other attribute to figure out that the processing in question was generation of spectral images from basis images.

Closed Issues:

Q. Include the Legacy Converted Enhanced CT Image Storage - For Processing SOP Class?

A: Yes.

Basis images created as CT Image Storage – For Processing SOP Class might get converted later to an Enhanced SOP Class for efficiency or compatibility reasons. The Legacy Converted Enhanced CT Image Storage - For Processing SOP Class would then be applicable.

Q. Can “for presentation” and “for processing” images be mixed in an Enhanced instance?

A: No.

Presentation Intent is a series level attribute so the value applies to all images in the series. (Note it only represents intent.)

Q. Can we remove the Presentation Intent attribute (here and in other SOP Classes) since it is somewhat redundant with the SOP Class semantics?

A: No.

Need to maintain symmetry. Can't remove in DX etc. because it's Type 1 so that's breaking.

Changes to NEMA Standards Publication PS 3.3

Part 3: Service Class Specifications

Add Presentation Intent to CT Series Module in PS3.3

C.8.15.1 CT Series Module

...

Table C.8-113. CT Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of device, process or method that originally acquired the data used to create the images in this Series. Enumerated Values: CT See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
<u>Presentation Intent Type</u>	<u>(0008,0068)</u>	<u>1C</u>	<u>Identifies the intent of the images that are contained within this Series.</u> <u>Enumerated Values:</u> <u>FOR PRESENTATION</u> <u>FOR PROCESSING</u> <u>Required if the SOP Class UID of this instance is 1.2.840.10008.5.1.4.1.1.2.XXUID (CT Image Storage - For Processing) or 1.2.840.10008.5.1.4.1.1.2.YYUID (Enhanced CT Image Storage - For Processing) or 1.2.840.10008.5.1.4.1.1.2.ZZUID (Legacy Converted Enhanced CT Image Storage - For Processing)</u> <u>See Section C.8.15.1.1.1 for further explanation.</u>

Add Attribute description section to CT Series Module. Text mirrors DX Series Module text

C.8.15.1.1 CT Series Module Attribute Descriptions

C.8.15.1.1.1 Presentation Intent Type

Presentation Intent Type (0008,0068) shall identify the intent for the purposes of display or other presentation of all Images within this Series.

Notes

1. Since this is a Series level Attribute, all Images within a Series have the same Value for this Attribute.
2. The intent of this restriction is to ensure that FOR PRESENTATION and FOR PROCESSING images are placed in separate Series, so that no confusion can arise as to which images are suitable for diagnostic reading as determined by local policy.

A Series of Images intended for viewing by an observer, after application of any grayscale transformations specified in the image object such as VOI LUT, shall, if Presentation Intent Type (0008,0068) is present, have an Enumerated Value of FOR PRESENTATION.

Notes

1. These images may still be of Image Type (0008,0008) ORIGINAL rather than DERIVED despite the possibility that they may have undergone some processing. In this case a DERIVED image would have undergone yet further processing to make it substantially different from the original.
2. These images may still be subjected to processing or further processing, if appropriate, depending on the application.
3. These images are intended for display on a device, without (further) processing, since that device may not be capable of image processing. The quality of the displayed image or its suitability for any purpose is beyond the scope of the DICOM Standard.

Images that are intended to be further processed before being displayed shall have an Enumerated Value of FOR PROCESSING.

Notes

1. This type is provided to allow the functions of image acquisition and image processing for presentation to be separated and yet have images conveyed between the two processes using a DICOM object. Individual sites or users may choose to substitute their own specialized processing in place of that supplied by the implementer.
2. Images available at this stage of processing may be useful for quality control and problem solving purposes, as well as academic research.
3. Images of this type may also be archived, retrieved and processed with different algorithms or parameters in order to alter the appearance of specific features for clinical purposes.
4. The nature of the processing that may have been applied before sending an image of type FOR PRESENTATION is also not specified.

Whether or not the spatial locations of all pixels are preserved during the processing of the source image that resulted in the current image can be indicated by Spatial Locations Preserved (0028,135A) in a Source Image Sequence (0008,2112) reference from the FOR PRESENTATION image to a FOR PROCESSING predecessor.

If images from the same exposure exist with different Values of Presentation Intent Type (0008,0068), then they shall have different SOP Instance UIDs.

Notes

1. Source Image Sequence (0008,2112) may be used to relate these images.
2. The SOP Class UIDs of the two images will also be different.

Changes to NEMA Standards Publication PS 3.4

Part 4: Service Class Specifications

Add SOPs to Table B.5-1 in PS3.4 Annex B.5.

Table B.5-1 Standard SOP Classes

SOP Class Name	SOP Class UID	IOD Specification (defined in PS3.3)	Specialization
...			
Digital Intra-Oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.3	Digital Intra-Oral X-Ray Image IOD	B.5.1.3
Digital Intra-Oral X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.3.1	Digital Intra-Oral X-Ray Image IOD	B.5.1.3
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	CT Image IOD	<u>B.5.1.XX</u>
<u>CT Image Storage - For Processing</u>	<u>1.2.840.10008.5.1.4.1.1.2.XXUID</u>	<u>CT Image IOD</u>	<u>B.5.1.XX</u>
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1	Enhanced CT Image IOD	B.5.1.7 B.5.1.23 <u>B.5.1.XX</u>
<u>Enhanced CT Image Storage - For Processing</u>	<u>1.2.840.10008.5.1.4.1.1.2.YYUID</u>	<u>Enhanced CT Image IOD</u>	<u>B.5.1.XX</u>
Legacy Converted Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.2	Legacy Converted Enhanced CT Image IOD	B.5.1.7 B.5.1.23 <u>B.5.1.XX</u>
<u>Legacy Converted Enhanced CT Image Storage - For Processing</u>	<u>1.2.840.10008.5.1.4.1.1.2.ZZUID</u>	<u>Legacy Converted Enhanced CT Image IOD</u>	<u>B.5.1.XX</u>
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	Ultrasound Multi-frame Image Storage	
...			

Add Section B.5.1.XX to PS3.4 Annex B.5.

This text is patterned after the corresponding text for DX in B.5.1.1.

(Any suggestions to improve the form of this language should be a CP to fix the other corresponding sections too.)

B.5.1.XX CT Image Storage SOP Classes

The CT Image Storage SOP Class shall use the CT Image IOD, and if Presentation Intent Type (0008,0068) is present, shall have an Enumerated Value of FOR PRESENTATION.

The Enhanced CT Image Storage SOP Class shall use the Enhanced CT Image IOD, and if Presentation Intent Type (0008,0068) is present, shall have an Enumerated Value of FOR PRESENTATION.

The Legacy Converted Enhanced CT Image Storage SOP Class shall use the Legacy Converted Enhanced CT Image IOD, and if Presentation Intent Type (0008,0068) is present, shall have an Enumerated Value of FOR PRESENTATION.

The CT Image Storage - For Processing SOP Class shall use the CT Image IOD with an Enumerated Value of FOR PROCESSING for Presentation Intent Type (0008,0068).

The Enhanced CT Image Storage - For Processing SOP Class shall use the Enhanced CT Image IOD with an Enumerated Value of FOR PROCESSING for Presentation Intent Type (0008,0068).

The Legacy Converted Enhanced CT Image Storage - For Processing SOP Class shall use the Legacy Converted Enhanced CT Image IOD with an Enumerated Value of FOR PROCESSING for Presentation Intent Type (0008,0068).

An SCU or SCP of the CT Image Storage - For Processing SOP Class shall also support the CT Image Storage SOP Class in the same role.

An SCU or SCP of the Enhanced CT Image Storage - For Processing SOP Class shall also support the CT Image Storage SOP Class in the same role.

An SCU or SCP of the Legacy Converted Enhanced CT Image Storage - For Processing SOP Class shall also support the Legacy Converted Enhanced CT Image Storage SOP Class in the same role.

In the following notes, the CT Image Storage SOP Class, Enhanced CT Image Storage SOP Class, and Legacy Converted Enhanced CT Image Storage SOP Class will be collectively referred to as For Presentation SOP Classes.

Notes

1. The intent of the above requirements is to ensure a useful level of interoperability by avoiding the situation where an SCU might support only a given For Processing SOP Class and an SCP only the corresponding For Presentation SOP Class, or vice versa. The burden is therefore to support the corresponding For Presentation SOP Class as a "baseline".
2. The term "support" is used in this section in the sense that an SCU or SCP must be capable of sending or receiving the For Presentation SOP Class. There is no intent to imply that an SCU must always send an instance of the For Presentation SOP Class when an instance of the For Processing SOP Class is sent.

Nor is there any intent to imply that during Association establishment, that a Presentation Context for the For Presentation SOP Class has to be proposed by the initiator. However, an association acceptor may reject a For Presentation SOP Class Presentation Context if it accepts a For Processing SOP Class Presentation Context, and prefers that SOP Class, in which case it may no longer be able to "pass on" the object later as an SCU unless it is able to generate a For Presentation object.

It is not possible for an SCP to determine from proposed Presentation Contexts whether or not an SCU "supports" (is capable of sending) both For Processing and For Presentation SOP Class Instances. Such a determination requires a priori knowledge of the information contained in the

Conformance Statement for the SCU, as well as how the SCU is configured and operated. An SCU that supports both SOP Classes may well choose to only propose one or the other during Association establishment, depending on which Instances it actually intends to send over that particular association (although the SCU must be capable of sending instances of the For Presentation SOP Class if the SCP does not accept the For Processing).

The intent of the requirement is that if an SCU is only capable of sending the For Presentation SOP Class, any SCP will be guaranteed to be able to receive it. Conversely, if an SCP is only capable of receiving the For Presentation SOP Class, any SCU will be guaranteed to be able to send it.

Sections PS3.4 B.5.1.7 and B.5.1.23. are included unchanged for reference

B.5.1.7 Enhanced CT Image Storage and Legacy Converted Enhanced CT Image Storage SOP Class

An SCP of the Enhanced CT Image Storage or Legacy Converted Enhanced CT Image Storage SOP Class shall also support the Grayscale Softcopy Presentation State Storage SOP Class as an SCP.

Note

This requirement is present in order to allow the exchange of graphical annotations created by an acquisition or conversion device.

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B.5.1.23 Enhanced Multi-Frame Image SOP Classes

An SCP of any of the Enhanced Multi-Frame Image SOP Classes that makes SOP Instances available through the Enhanced Multi-Frame Image Conversion Extended Negotiation of the Query/Retrieve Service Class (see [Section C.3.5](#)) shall support Storage Level 2 (Full).

Note

Effective use of the Image Conversion option requires the storage of Type 3 Attributes.

Changes to NEMA Standards Publication PS 3.6

Part 6: Data Dictionary

Add the SOP Class UIDs for the new SOP Classes to Table A-1 PS3.6 Annex A

UID Value	UID Name	UID Keyword	UID Type	Part
...				
<u>1.2.840.10008.5.1.4.1.1.2.XXUID</u>	<u>CT Image Storage - For Processing</u>	<u>CTImageStorageForProcessing</u>	<u>SOP Class</u>	<u>PS3.4</u>
<u>1.2.840.10008.5.1.4.1.1.2.YYUID</u>	<u>Enhanced CT Image Storage - For Processing</u>	<u>EnhancedCTImageStorageForProcessing</u>	<u>SOP Class</u>	<u>PS3.4</u>

<u>1.2.840.10008.5.1.4.1.1.2.ZZUID</u>	<u>Legacy Converted Enhanced CT Image Storage - For Processing</u>	<u>LegacyConvertedEnhanced CTImageStorageForProcessing</u>	<u>SOP Class</u>	<u>PS3.4</u>
...				

Changes to NEMA Standards Publication PS 3.16

Part 16: Data Dictionary

Add a code to CID 7202 Source Image Purpose of Reference for use in Source Image Sequence (0008,2112) to point to Basis instances from which spectral images were derived.
See General Reference Module PS3.3 C.12-10.

CID 7202 Source Image Purpose of Reference

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML
Keyword: SourceImagePurposeOfReference
FHIR Keyword: dicom-cid-7202-SourceImagePurposeOfReference
Type: Extensible
Version: 20170405yyymmdd
UID: 1.2.840.10008.6.1.509

Table CID 7202. Source Image Purpose of Reference

Coding Scheme Designator	Code Value	Code Meaning
DCM	121320	Uncompressed predecessor
DCM	121321	Mask image for image processing operation
DCM	121322	Source image for image processing operation
DCM	121329	Source image for montage
DCM	121330	Lossy compressed predecessor
DCM	121358	For Processing predecessor
DCM	113130	Predecessor containing group of imaging subjects
DCM	128250	Structural image for image processing
DCM	128251	Flow image for image processing
<u>DCM</u>	<u>Newcode1</u>	<u>Basis image for spectral processing</u>

Add definitions to PS 3.16 Annex D

Table D-1. DICOM Controlled Terminology Definitions

Code Value	Code Meaning	Definition	Notes
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<u>Newcode1</u>	<u>Basis image for spectral processing</u>	<u>Multi-energy CT basis image used as the source for derivation of a spectral image.</u>	
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