DICOM Correction Proposal

STATUS	Final Text
Date of Last Update	2021/01/20
Person Assigned	Harry Solomon
Submitter Name	Sander Dekker, Harry Solomon
Submission Date	2019/06/17

Correction Number CP-1975
Log Summary: Active image region overlay
Name of Standard PS3.3, PS3.6 2020e
Rationale for Correction: Ultrasound Imaging system QA fully relies on digital image output of the imaging systems. The image QA is performed directly on pixel data representing the active image region of the transducer (e.g., the fan shaped area in the case of a sector transducer). For an accurate and automated analysis of ultrasound images for QA, it would be extremely helpful to know the location of these active pixels within the total image pixel matrix. Currently, physicists/sonographers/biomedical engineers performing QA or other image analysis have to guide the software by manually identifying the complex shape of the active image region of the transducer in the image. The equipment producing the image knows exactly where the active image region is, and having an automatically generated map of the active image region pixels would make it possible to skip this manual step and make image QA or other analysis fully automated, saving a considerable amount of time and providing greater accuracy. The map could also help improve the reproducibility of the measurements for QA and longitudinal patient exams, as it removes a manual variability from the process. Other analysis of the images for purposes such as improved CAD, identification of locally preferred system presets, and quantification of body structure properties requires the same active image region information. Having the active image region map available in the DICOM header also enables artificial intelligence applications for detecting anatomy and measuring distances and areas. This capability has theoretical applicability beyond the ultrasound modality, and could apply to any modality with an active image region smaller than the entire encoded image pixel matrix. Identification of the active image region is already envisioned in the standard, at least for the single frame Ultrasound Image IOD, using the existing overlay mechanism and a specialization of the Type 3 attribute Overlay Subtype (60xx,0045), which was specifically introduced in Supplement 4 for the ultrasound use case – see PS3.3 Section C.8.5.6.1.11. This CP elaborates on the use of this mechanism for this use case, and makes it applicable across modalities and multi-frame images as well, without breaking any implementation that uses the existing mechanism already described. If an Active Image Area Overlay is present in a SOP Instance and corresponds to a region specified in the US Region Calibration Module, a pointer to that overlay is added to the region description metadata. However, an Active Image Area Overlay can exist without the Region Calibration Module, and vice versa. This capability does not apply to the Enhanced Ultrasound Volume SOP Class, which would require use of a separate Segmentation SOP Instance.
Correction Wording:

A.6.4 US Image IOD Module Table

Table A.6-1 specifies the Modules of the US Multi-frame Image IOD.

Table A.6-1. US Image IOD Modules

IE	Module	Reference	Usage
…			
Image	General Image	C.7.6.1	M
	...		
	Overlay Plane	C.9.2	U
	…		

Note

1. ~~**For the purpose of conveying ultrasound protocol data management information, it is recommended that the Performed Protocol Code Sequence (0040,0260) be assigned the code value(s) of the performed ultrasound protocol, if any. For Performed Protocol Code Sequence (0040,0260) BCID 12001 "Ultrasound Protocol Types" may be used.**~~

2. ~~**2.**~~ The US Frame of Reference Module was previously included in this IOD, but has been retired. See PS3.3-2003.

…

A.6.4.2 US Image IOD Content Constraints

A.6.4.2.1 Series Performed Protocol

For the purpose of conveying ultrasound protocol data management information, it is recommended that the Performed Protocol Code Sequence (0040,0260) be assigned the code value(s) of the performed ultrasound protocol, if any. For Performed Protocol Code Sequence (0040,0260) BCID 12001 "Ultrasound Protocol Types" may be used.

A.6.4.2.2 Active Image Area Overlays

The Overlay Plane Module may be used to describe the active image area by use of an overlay. In this case, an Overlay Type (60xx,0040) value of R and an appropriate Overlay Subtype (60xx,0045) value is used.

…

A.7.4 US Multi-frame Image IOD Module Table

Table A.7-1 specifies the Modules of the US Multi-frame Image IOD.

Table A.7-1. US Multi-frame Image IOD Modules

IE	Module	Reference	Usage
…			
Image	General Image	C.7.6.1	M
	…		
	US Region Calibration	C.8.5.5	U
	US Image	C.8.5.6	M
	Overlay Plane	**C.9.2**	**U**
	Multi-frame Overlay	**C.9.3**	**C – Required if an Overlay Plane has multiple frames, or if an Overlay Plane is to be applied to specific image frames**
	…		

Note

1. ~~**For the purpose of conveying ultrasound protocol data management information, it is recommended that the Performed Protocol Code Sequence (0040,0260) be assigned the code value(s) of the performed ultrasound protocol, if any. For Performed Protocol Code Sequence (0040,0260) BCID 12001 "Ultrasound Protocol Types" may be used.**~~

~~**2.**~~ The US Frame of Reference Module was previously included in this IOD, but has been retired. See PS3.3-2003.

A.7.4.1 Mutually Exclusive IEs

Note

A Curve IE was previously included in this IOD that was mutually exclusive with the Image IE, but has been retired. See PS3.3-2004.

A.7.4.2 US Multi-frame Image IOD Content Constraints

A.7.4.2.1 Series Performed Protocol

For the purpose of conveying ultrasound protocol data management information, it is recommended that the Performed Protocol Code Sequence (0040,0260) be assigned the code value(s) of the performed ultrasound protocol, if any. For Performed Protocol Code Sequence (0040,0260) BCID 12001 "Ultrasound Protocol Types" may be used.

A.7.4.2.2 Active Image Area Overlays

The Overlay Plane Module and Multi-Frame Overlay Module may be used to describe the active image area by use of a either a single frame overlay that applies to all image frames, or per-frame overlays. In either case, an Overlay Type (60xx,0040) value of R and an appropriate Overlay Subtype (60xx,0045) value is used. In the case of a single frame overlay that applies to all image frames, the active area specified by such an active image area overlay will be at the same location in every frame of the image as specified in Section C.9.2 Overlay Plane Module.

…

C.9.2.1.3 Overlay Subtype

Defined Terms:

USER User created graphic annotation **or ROI** (e.g., operator)
AUTOMATED Machine or algorithm generated graphic annotation **or ROI**, such as output of a Computer Assisted Diagnosis algorithm
ACTIVE IMAGE AREA **Identification of the active area of an image**

Note

Additional or alternative Defined Terms may be specified in modality specific Modules, such as **the specific use of "ACTIVE 2D/BMODE IMAGE AREA" as described** in the **Section C.8.5.6.1.11** Overlay Subtype.

An active image area overlay identifies all pixels in the Pixel Data that are generated from image data acquisition. Each pixel in the active area shall have an overlay bit value of 1; all other bits are set to 0. Any area of burned in annotation (not generated from image data acquisition) shall be excluded from the active image area.

Note

1. **For example, the active image area overlay may delineate a non-rectangular (e.g., fan) shaped acquisition by an ultrasound transducer, or a circular reconstructed field of view from a tomographic acquisition.**

2. **Whether or not the excluded area of burned in annotation extends beyond the specifically modified pixels, e.g. to exclude an entire bounding box area around the text or graphic annotation, is not specified by the Standard.**

3. **The active image area for projection X-ray is specified by the Section C.8.7.3 X-Ray Collimator Module.**

…

C.8.5.5 US Region Calibration Module

The US Region Calibration Module has been introduced into the ultrasound IOD to provide access to the full range of data that may be present in a single US image. US images often contain multiple regions that have independent data regions, e.g., quad screen loops that may have different calibration information. The data presented in the various regions of a US image can represent a multiplicity of physical parameters, e.g., spatial distance, blood velocity, time, volume, etc., and these are often contained in the value of the pixel itself. It is therefore imperative that physical information be available for the various regions of a single region independent of each other.

Table C.8-17 contains IOD Attributes that describe an ultrasound region calibration.

Table C.8-17. US Region Calibration Module Attributes

Attribute Name	Tag	Type	Attribute Description
Sequence of Ultrasound Regions	(0018,6011)	1	Defines a Sequence of Ultrasound Regions. One or more Items shall be included in this Sequence.
>Region Location Min x0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
>Region Location Min y0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
>Region Location Max x1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
>Region Location Max y1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
…			
>TM-Line Position y1	(0018,6043)	3	The starting and ending coordinates pairs of the m-line. Where the X0,Y0are the starting point and X1,Y1are the end point of the tm-line. See Section C.8.5.5.1.10 for further explanation.
>Active Image Area Overlay Group	**(0018,6070)**	**3**	**Specifies the Group (60xx) that contains an Overlay that identifies the active image area of the pixel data within this region, as defined in the Section C.9.2 Overlay Plane Module. See Section C.8.5.5.1.19 for further explanation.**

…

C.8.5.5.1.14 Region Location Min X0, Min Y0, Max X1 and Max Y1

These Attributes specify the location of the region, Region Location Min X0 (0018,6018), Region Location Min Y0 (0018,601A), Region Location Max X1 (0018,601C), Region Location Max Y1 (0018,601E) expressed as offsets to the pixel coordinates. The upper left corner of the entire image is x=0,y=0 and the lower right corner is x=~~**image width**~~**number of columns** - 1, and y=~~**image length**~~**number of rows** - 1. Thus, a region will be specified as within these bounds. Where x0,y0 is the coordinate of the upper left corner of the region and x1,y1 is the coordinate of the lower right corner of the region.

…

C.8.5.5.1.19 Active Image Area Overlay Group

In a 2D region, the field of view of the transducer typically does not extend to the edges of the defined region (e.g., for a fan shape as seen in the example in Figure C.8-6). The pixels that are within the field of view may be identified by an Overlay with Overlay Type (60xx,0040) value R and an Overlay Subtype (60xx,0045) of "ACTIVE 2D/BMODE IMAGE AREA" or "ACTIVE VOLUME FLOW IMAGE AREA" (see Section C.8.5.6.1.11 Overlay Subtype). The size and location of such a referenced Overlay shall be identical to the size and location of the defined region.

Note

For historical reasons, the specification of the ultrasound image region in Region Location Min X0 (0018,6018), Region Location Min Y0 (0018,601A), Region Location Max X1 (0018,601C), and Region Location Max Y1 (0018,601E) uses 0\0 to identify the top left pixel of the image, whereas the specification of the overlay in Overlay Origin (60xx,0050) uses 1\1 to identify the top left pixel.

…

C.8.5.6 US Image Module

Table C.8-18 specifies the Attributes that describe ultrasound images.

Table C.8-18. US Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Samples Per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.8.5.6.1.12 for specialization
…			
Overlay Subtype	(60xx,0045)	~~3~~**1C**	Defined Term that identifies the intended purpose of the ROI Overlay Type. **Required if this Overlay Group is referenced in an Item of the Sequence of Ultrasound Regions (0018,6011). May be present otherwise.** See Section C.8.5.6.1.11 for specialization.

…

C.8.5.6.1.11 Overlay Subtype

Defined Terms:

ACTIVE 2D/BMODE IMAGE AREA identification of the active area of a 2D/B-mode image

ACTIVE VOLUME FLOW IMAGE AREA identification of the active area of volume flow in an image

Notes

1. For historical reasons, the Ultrasound-specific term "ACTIVE 2D/BMODE IMAGE AREA" is used rather than the more generally applicable term "ACTIVE IMAGE AREA" described in Section C.9.2.1.3 Overlay Subtype, but the same semantics are applicable.

2. An Overlay with an Overlay Subtype (60xx,0045) of one of these Defined Terms may be referenced from an Item of the Sequence of Ultrasound Regions (0018,6011). See Section C.8.5.5 US Region Calibration Module.

PS3.6

Table 6-1. Registry of DICOM Data Elements

Tag	Name	Keyword	VR	VM	
(0018,6070)	**Active Image Area Overlay Group**	**ActiveImageAreaOverlayGroup**	**US**	**1**	