

2

4

6

Digital Imaging and Communications in Medicine (DICOM)

8

Supplement 48: Ultrasound Image IOD extensions for Intravascular Ultrasound (IVUS)

10

12

14

16

18

VERSION: Final Text Sep 10, 2001

20

22

24 **DICOM Standards Committee**

26 1300 N. 17th Street, Suite 1847
Rosslyn, Virginia 22209

28

30 **Introduction**

32 DICOM Working Group 1 - Cardiac and Vascular Information has undertaken a work task to develop this
34 proposed DICOM Supplement to address the interchange of Intravascular Ultrasound (IVUS) images and
related data in DICOM as part of a catheterization procedure. The existing Ultrasound IODs will be extended
to accommodate IVUS images.

DOMAIN OF APPLICATION

36 IVUS acquisition is part of cardiac catheterization and peripheral vascular medical imaging.

38 The domain of this Supplement is IVUS acquisition within the cardiac and peripheral vascular catheterization
39 procedure context. It is specifically meant to address IVUS image acquisitions which will be analyzed with
40 other data which is transferred and managed using the DICOM protocol. It allows the addition of IVUS
41 images and related data to that context with minimal incremental cost. Further, it leverages the DICOM
42 persistent object capability for maintaining referential relationships to other data collected in a multi-modality
environment, including references necessary for multi-modality temporal synchronization.

TIME SYNCHRONIZATION FRAME OF REFERENCE

44 Synchronization of acquisition across multiple modalities in a single study (e.g., fluoroscopy and IVUS)
45 requires either a shared trigger, or a shared clock. The DICOM Standard includes a Synchronization Module
46 within the Frame of Reference Information Entity to specify the synchronization mechanism (C.7.4.2). This
Supplement proposes to use this same synchronization mechanism.

AUDIO AND EKG WAVEFORMS FOR IVUS ACQUISITION

50 The IVUS use model requires the simultaneous acquisition of images and waveforms (audio and/or ECG).
52 The audio channel allows the IVUS digital acquisition to emulate a videotape recording of an IVUS procedure,
54 in which the performing physician provides verbal annotation of regions of interest during image acquisition.
The ECG channel allows post-processing of the IVUS image to select frames at a particular cardiac phase
(e.g., systole) in order to minimize wall motion artifacts.

56 This Supplement requires the images and waveforms to be carried in separate SOP Instances, rather than in
a single object incorporating both images and waveforms. There are benefits to separating the image and
58 waveform “streams” from the perspective of the maintenance and evolution of the DICOM Standard (e.g., to
allow better specification of compression transfer syntaxes).

30

32

34

Changes to:

36

PS 3.3-2000 Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

38

70 **1. Add modules to US Image and US Multi-frame Image information object definitions for IVUS**

72

A.6.4 US IMAGE IOD MODULES

74

Table A.6-1 US IMAGE IOD Modules

IE	Module	Reference	Usage
Frame of Reference	<u>Synchronization</u>	<u>C.7.4.2</u>	<u>U</u>

76

78

A.7.4 US MULTI-FRAME IMAGE IOD MODULES

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

IE	Module	Reference	Usage
Frame of Reference	<u>Synchronization</u>	<u>C.7.4.2</u>	<u>C – Required if Modality (0008,0060) = IVUS.</u> <u>May be present otherwise.</u>

30

2. *Modify Section C.7.3.1.1.1 Modality: Add Defined Term for Modality (0008,0060)*

32 Defined Terms for the Modality (0008,0060) are:

...

34 **IVUS = Intravascular Ultrasound**

3. *Modify Section C.7.4.2.1.4 Acquisition Time Synchronized to apply to non-waveform objects*

36 The Acquisition Time Synchronized (0018,1800) attribute specifies whether the Acquisition Datetime
38 (0008,002A) attribute of the Waveform **Identification** Module **or the General Image Module** represents an
39 accurate synchronized timestamp for the acquisition of the waveform **and/or image data**. **For triggered multi-**
30 **frame images, the Acquisition Datetime applies to the trigger for the first image frame (see attribute**
Image Trigger Delay (0018,1067) in the Cine Module).

32

4. *Modify Section C.8.5.6.1.1 to add defined term for Value 4 for Image Type*

34 Value 4 is constructed as a modality bit map to allow for a description of multi-modality displays. In using this
36 bit map, the sum of the values of the various modalities will unambiguously determine the constituent
modalities.

0001 = 2D Imaging	0002 = M-Mode	0004 = CW Doppler
0008 = PW Doppler	0010 = Color Doppler	0020 = Color M-Mode
0040 = 3D Rendering	0100 = Color Power Mode	

38

5. *Modify Section C.8.5.6 to add new IVUS attributes and the Referenced Waveform Sequence.*

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
...
<u>Acquisition Datetime</u>	(0008,002A)	1C	The date and time that the acquisition of data that resulted in this image started. Required if Modality (0008,0060) = IVUS May be present otherwise. Note: The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).
<u>IVUS Acquisition</u>	(0018,3100)	1C	Defined Terms: MOTOR_PULLBACK MANUAL_PULLBACK SELECTIVE GATED_PULLBACK See C.8.5.6.1.21 Required if Modality (0008,0060) = IVUS
<u>IVUS Pullback Rate</u>	(0018,3101)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK. Specified in units of mm/sec. See C.8.5.6.1.22
<u>IVUS Gated Rate</u>	(0018,3102)	1C	Required if IVUS Acquisition (0018,3100) value is GATED_PULLBACK. Specified in units of mm/beat. See C.8.5.6.1.23
<u>IVUS Pullback Start Frame Number</u>	(0018,3103)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK or GATED_PULLBACK. See C.8.5.6.1.24
<u>IVUS Pullback Stop Frame Number</u>	(0018,3104)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK or GATED_PULLBACK. See C.8.5.6.1.25
<u>Lesion Number</u>	(0018,3105)	3	Identifier(s) of the lesion(s) of interest imaged within the current SOP Instance. Each lesion shall have a unique numeric integer identifier within the study.

			<u>See C.8.5.6.1.26</u>
<u>Referenced Waveform Sequence</u>	<u>(0008,113A)</u>	<u>3</u>	<u>References to waveforms acquired in conjunction with this image. These Waveforms may or may not be temporally synchronized with this image. One or more Items may be included in this Sequence.</u>
<u>>Include 'SOP Instance Reference Macro' Table C.17-3</u>			
<u>>Purpose of Reference Code Sequence</u>	<u>(0040,A170)</u>	<u>1</u>	<u>Code describing the purpose of the reference to the waveform(s). Only a single Item shall be permitted in this sequence.</u>
<u>>>Include 'Code Sequence Macro' Table 8.8-1</u>		<u>Defined Context ID is CID 7004</u>	

36

C.8.5.6.1 US Image Attribute Descriptions

38 ...

C.8.5.6.1.18 Primary Anatomic Structure Sequence

10 ...

12 Note: The Defined Context ID for IVUS modality images is CID 3010 and CID 3014 (see PS3.16). For Primary Anatomic Structure Modifier Sequence the Defined Context ID for IVUS modality images is CID 3019 (see PS3.16).

14

C.8.5.6.1.21 IVUS Acquisition

16 This attribute denotes which of the following defined terms describes the method used to acquire the IVUS Images.

18 **MOTOR PULLBACK:** The IVUS imaging catheter is positioned in the blood vessel under examination distal to the anatomical structures to be examined. Then the catheter is attached to a motorized mechanism capable of withdrawing the catheter through the vessel at a constant velocity specified by the attribute IVUS Pullback Rate (0018,3101) from the defined IVUS Pullback Start Frame Number (0018,3103) (see C.8.5.6.1.24) to the IVUS Pullback Stop Frame Number (0018,3104) (see C.8.5.6.1.25).

24 **MANUAL PULLBACK:** The IVUS imaging catheter is positioned in the blood vessel under examination distal to the anatomical structures to be examined. Then the catheter is manually withdrawn through the vessel region of interest.

28 **SELECTIVE:** The IVUS imaging catheter is positioned in the blood vessel under examination near the anatomical structures to be examined. Then the catheter is manually withdrawn or advanced through the vessel region of interest.

30 **GATED PULLBACK:** The IVUS imaging catheter is positioned in the blood vessel under examination distal to the anatomical structures to be examined. Then the catheter is attached to a motorized mechanism capable of withdrawing the catheter through the vessel at a rate specified by the attribute IVUS Gated Rate (0018,3102), once per heart cycle, from the defined IVUS Pullback Start Frame Number (0018,3103) (see C.8.5.6.1.24) to the IVUS Pullback Stop Frame Number (0018,3104) (see C.8.5.6.1.25).

32

34

36 **C.8.5.6.1.22 IVUS Pullback Rate**

38 **The attribute IVUS Pullback Rate (0018,3101) is required when IVUS Acquisition (0018,3100) is MOTOR_PULLBACK and it specifies the velocity of withdrawal of the IVUS imaging catheter in millimeters per second.**

40 **C.8.5.6.1.23 IVUS Gated Rate**

42 **The attribute IVUS Gated Rate (0018,3102) is required when IVUS Acquisition (0018,3100) is GATED_PULLBACK and it specifies the velocity of withdrawal of the IVUS imaging catheter in millimeters per beat.**

44 **C.8.5.6.1.24 IVUS Pullback Start Frame Number**

46 **The IVUS Pullback Start Frame Number (0018,3103) specifies the frame number of a IVUS multi-frame acquisition upon which motorized or gated pullback begins.**

C.8.5.6.1.25 IVUS Pullback Stop Frame Number

48 **The IVUS Pullback Stop Frame Number (0018,3104) specifies the frame number of a IVUS multi-frame acquisition upon which motorized or gated pullback ends.**

50 **C.8.5.6.1.26 Lesion Number**

52 **Attribute Lesion Number identifies the lesion(s) of interest imaged within the current SOP Instance. Each lesion shall have a unique numeric integer identifier within the study. If during a study the same lesion is imaged more than once, the same Lesion Number should be used for both SOP Instances.**

54 **Note: 1.Lesion Number is not a DICOM UID.**
2.An IVUS pullback may contain multiple values in Lesion Number.

Changes to:

PS 3.6-2000 Digital Imaging and Communications in Medicine (DICOM)

Part 6: Data Dictionary

6. Add new Attributes to Section 6

Tag	Attribute Name	VR	VM
(0018,3100)	IVUS Acquisition	CS	1
(0018,3101)	IVUS Pullback Rate	DS	1
(0018,3102)	IVUS Gated Rate	DS	1
(0018,3103)	IVUS Pullback Start Frame Number	IS	1
(0018,3104)	IVUS Pullback Stop Frame Number	IS	1
(0018,3105)	Lesion Number	IS	1-n
(0008,113A)	Referenced Waveform Sequence	SQ	1
(0040,A170)	Purpose of Reference Code Sequence	SQ	1

Changes to:

PS 3.16 Digital Imaging and Communications in Medicine (DICOM)

Part 16: DICOM Content Mapping Resource

CID 7004

WAVEFORM PURPOSES OF REFERENCE

(Most restrictive use: Defined)

<u>Coding Scheme Designator (0008,0102)</u>	<u>Code Value (0008,0100)</u>	<u>Code Meaning (0008,0104)</u>
DCM	121301	Simultaneous Doppler
DCM	121302	Simultaneous Hemodynamic
DCM	121303	Simultaneous ECG
DCM	121304	Simultaneous Voice Narrative