

INTEGRATED DIGITAL INTERFACE

Technical Data
Software Version B.2

DICOM CONFORMANCE STATEMENT

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REVISION HISTORY

Production Change Order	Rev	Date	Affected Sections/Pages	Summary of Change(s)
	B.0	3/15/99		As released
	B.1	6/29/00	Table 7: Patient Table 6: US Image IOD Modules & Table 18: US Multi-Frame Image IOD Modules 2.1.1.1 & 2.2.1.1 2.1.2.4.1 various 1.2.2, 2.1.3, 2.2.3 2.1.2.4.2.1 2.1.2.4.1	Correct "Patient Birthdate" Correct "Contrast/Bolus" Correct max PDU size Correct warning handling. HP to Agilent changes Added Verification Service Added Performed Location Code 0111 treated as Warning
	B.2	12/03/00	Various	Dicomit Print Agent. Section numbering. Correct Styles. Monochrome and Miscellaneous switches

0 Introduction

DICOM (Digital Imaging and Communications in Medicine) is a standard that specifies how images and related clinical information are passed between medical devices that produce or use this data. The DICOM conformance statement is a required document for any device claiming conformance to DICOM.

This document defines the conformance of Agilent Technologies's ultrasound imaging systems configured with the Integrated Digital Interface (IDI) option. In particular, the DICOM system interface and capabilities are described. While the DICOM Conformance Statement is not intended to be a complete IDI product specification, some areas of this document will reference system operation where it is necessary to add a context for the discussion or to help explain a capability.

Print Agent is an application that is capable of sending DICOM Images to a remote DICOM Printer.

Print Agent is a slave application controlled by a host application through window messaging, and detailed printing instructions are provided in a text file by the host.

Print Agent supports the following DICOM Service Class:

Print Management Service Class (SCU)

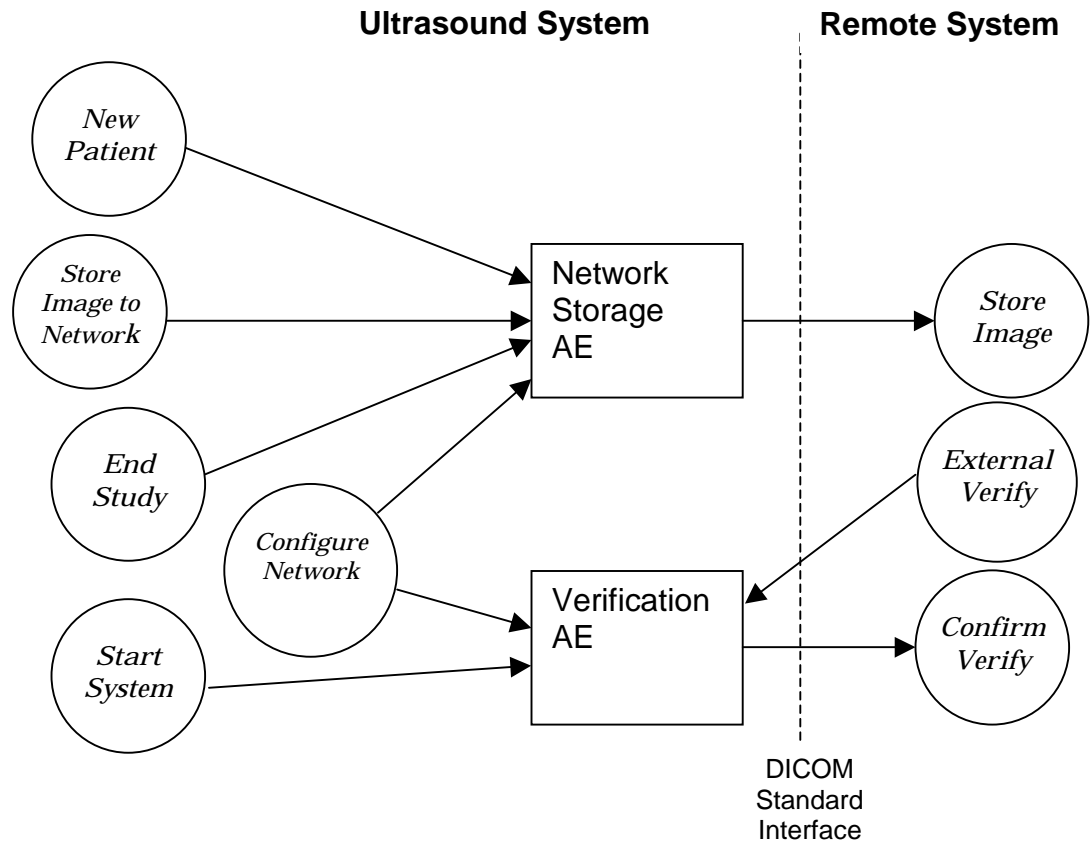
Definitions of Information Object and Communication Protocols are provided in this document.

0.1 References

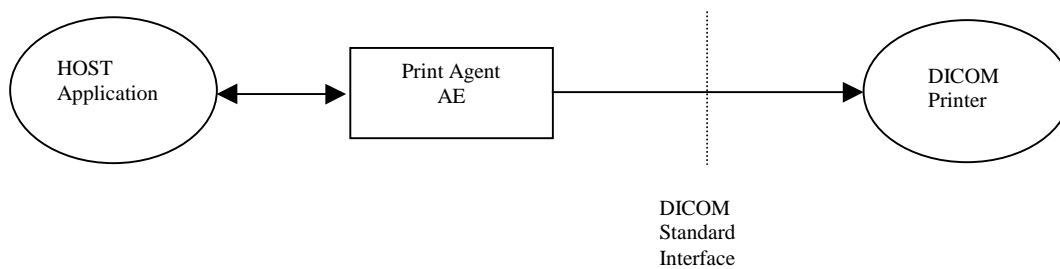
ACR-NEMA Digital Imaging and Communications in Medicine, DICOM V3.0, 1998, 1999

1 Implementation Model

1.1 Application Data Flow Diagram



The Figure shows relationship between Print Agent Application Entity and a remote DICOM Printer.



1.2 Functional Definition of Application Entities

1.2.1 Network Storage AE

The ultrasound system provides a set of configuration menus used to set up the network interface and storage options. The configurable options include specification of the DICOM storage server (name, port number, AE title), type of compression used, and institution name. Note that while IDI configuration determines the set of transfer syntaxes to be proposed and the order in which they are proposed, the actual transfer syntax for each association is selected by the Storage SCP from the proposed choices. A complete description of the configurable items and their effect on system operation is in the configuration section of this document.

Study and Series UIDs are generated based on real-world events from the ultrasound system. An explicit *End Study* event initiates the transfer of all image objects in the study and indicates that subsequent objects refer to new study/patient information.

The Network Storage AE internally queues the clinical and image data communicated by *Store Image to Network* events from the ultrasound system and sends it to the remote storage SCP when the study finishes. Each communicated object will be either an Ultrasound Image Information Object or an Ultrasound Multi-frame Image Information Object. The Network Storage AE transfers each object to the remote storage system through the Storage Service Class, and in particular the C-STORE standard service as a SCU. The Network Storage AE monitors the state of the association to the Storage SCP and uses the C-STORE response status indicator to assure each image is successfully transferred to the Storage SCP. If the Network Storage AE fails to make a network connection to the Storage SCP, or loses the connection during a transfer, it periodically attempts to reestablish the connection. Once the connection is established, transfer of images is resumed. Images are not removed from local storage until each image is successfully transferred to the Storage SCP.

1.2.2 Print Agent AE

Print Agent AE sends print studies/images to a remote DICOM Print device. It therefore performs the following tasks:

- Builds DICOM Basic Grayscale, Color Print Objects.
- Establishes DICOM Association with remote DICOM Print device.
- Performs transmit of DICOM Basic Grayscale, Color Print Objects to remote DICOM Print device.

1.2.3 Verification both as SCU AE and SCP

The Verification AE is a support application that assists the user in configuration and troubleshooting of network connections. Verification AE uses the C-ECHO

service to verify a connection to a server, either explicitly through a user command, or implicitly when the system is started or a new server is selected.

In addition if a verification Association is initiated by a remote entity, IDI will automatically respond with a success message, provided the requested AE Title matches the IDIs AE Title.

1.3 Sequencing of Real-World Activities

1.3.1.1 Network

Configuring the network must be done prior to other activities requiring network action from the ultrasound system. Appropriate association negotiation is done each time a network service is required (verifying the server or beginning transfer of images within a study).

1.3.1.2 Print

- Operator specifies some of film attributes as desired, such as display format, orientation on each film, etc.
- Operator acquires print images.
- Print requests are placed on a queue, and are executed in the background.
- When the study or image transfer fails, Print Agent AE attempts to re-send the study or image automatically.

2 Application Entity Specifications

2.1 Network Storage AE Specification

The Network Storage AE provides standard conformance to the DICOM SOP Classes listed in Table 1.

SOP Class Name	SOP Class UID	Role
Ultrasound Multi-frame Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.3.1	SCU
Ultrasound Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.6.1	SCU

Table 1: SOP Classes Supported by Network Storage AE

2.1.1 Association Establishment Policies

2.1.1.1 General

Maximum PDU size offered: 258,048 bytes, and is configurable.

2.1.1.2 Number of Associations

Only one association is established at a time. Network Storage AE will use this association for all Storage SOP classes.

2.1.1.3 Asynchronous Nature

Multiple outstanding transactions are not supported. Replies are handled for the current transaction before another may be initiated.

2.1.1.4 Implementation Identifying Information

The Integrated Digital Interface is identified as shown in Table 2. Note that “xxxxx” in the Implementation Version Name is a string designating the IDI software version number.

Element	Implementation Value
Implementation Class UID	1.2.840.113543.6.6.1.1
Implementation Version Name	“IDI_XXXXX”

Table 2: Implementation Identifying Information

2.1.2 Association Initiation By Real-World Activity

2.1.2.1 Configure Network Real-World Activity

The *Configure Network* activity does not initiate any association or services over the DICOM interface for the Network Storage AE. Configurable items will determine module attribute values, negotiation syntax order, and the application entity acting as SCP for subsequent storage actions. See the Configuration section of this document for more details.

2.1.2.2 New Patient Real World Activity

The *New Patient* activity causes study instance and series instance UIDs to be generated for use in subsequent *Store Image to Network* and *End Study* activities.

2.1.2.3 Store Image to Network Real World Activity

The *Store Image to Network* activity causes the storage of the image and clinical data to local storage. The study information such as the Study Instance UID is determined from the Network Storage AE and is associated with the image as it is generated. This activity is repeated for each image in the study.

2.1.2.4 End Study Real World Activity

2.1.2.4.1 Associated Real-World Activity

The *End Study* activity has the effect of ending the current study and initiating the transfer of

the stored study over the network to the Storage SCP. An association is opened, and a C-STORE event is initiated for each image in the study. The Network Storage AE monitors the association status and uses the status indicator returned from the Storage SCP in determining the disposition of each image in the study: Table 3 describes the behavior of the Network Storage AE in response to various error conditions and C-STORE-RSP status indicators. After all images in the study have been processed according to the behavior in Table 3, the association is closed.

Condition	Status Codes	Response
No Response (response timeout)	none	Image object is kept in queue of objects to transfer. The open association is aborted, and after a wait period a new association is opened and storage is re-attempted.
Lost Association	none	Image object is kept in queue of objects to transfer. After a wait period, a new association is opened and storage is re-attempted
Refused	A7xx	Image object is kept in queue of objects to transfer. The open association is closed, and after a wait period a new association is opened, and storage is re-attempted. The failure is logged.
Error	A9xx, Cxxx, 0122, other	Image object is removed from queue of objects to transfer but kept on internal storage. The failure is logged.
Warning	Bxxx, 0111	Ignored - actions are the same as “success” condition. The warning is logged.
Success	0000	Image object is removed from queue of objects to transfer.

Table 3: Responses to Image Storage Error Conditions

2.1.2.4.2 Proposed Presentation Contexts

Only one association is established per study transfer. Each time the Network Storage AE initiates an association in response to the *End Study* real-world activity, it requests services summarized in Table 4. Note that the particular transfer syntaxes proposed and the order in which they are proposed are subject to user configuration. Transfer syntax is independently configurable for single-frame and multi-frame images. See the Configuration section of this document for details.

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Ultrasound Multi-frame Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.3.1	JPEG Baseline (Process 1): Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression	1.2.840.10008.1.2.4.50	SCU	None
		RLE Lossless	1.2.840.10008.1.2.5		
		Implicit VR Little Endian	1.2.840.10008.1.2		
Ultrasound Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.6.1	JPEG Baseline (Process 1): Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression	1.2.840.10008.1.2.4.50	SCU	None
		RLE Lossless	1.2.840.10008.1.2.5		
		Implicit VR Little Endian	1.2.840.10008.1.2		

Table 4: Proposed Presentation Contexts

The values of certain image attributes used in the transfer of each image depends on a number of factors, including the transfer syntax accepted by the Storage SCP and the type of the image. Table 5 describes the relationships among these parameters.

Negotiated Transfer Syntax	Image Type	Resultant Attribute Values	
		Photometric Interpretation	Samples per Pixel and Bits per Sample
JPEG Baseline	All	YBR_FULL_422	3 8-bit samples / pixel
RLE	BW Image ¹	PALETTE_COLOR	1 8-bit sample / pixel
	Color Image ²	PALETTE_COLOR	1 16-bit sample / pixel
	VCR Capture, Angio	RGB	3 8-bit samples / pixel
Implicit VR Little Endian.	BW Image	PALETTE_COLOR Or MONOCHROME2, if Configured	1 8-bit sample / pixel
	Color Image, VCR Capture, Angio	RGB Or MONOCHROME2, if Configured	3 8-bit samples / pixel 1 8-bit sample / pixel

Table 5: Image Attributes based upon Transfer Syntax and Image Type

2.1.2.4.2.1 Conformance for Image Storage SOP Class

¹ BW Image refers to any 8-bit sample mode (for example, a "Colorization" image is an 8-bit sample image, which maps a sample to a color instead of a gray scale value).

² Color Image refers to most 16-bit sample modes (including images produced in Color Flow, Acoustic Quantification, Acoustic Densitometry, and Color Kinesis modes).

The C-STORE event will indicate an Ultrasound Image Storage SOP Class. The Ultrasound Image Storage SOP uses the Ultrasound Image IOD's modules as follows:

IE	Module	Required	Usage
Patient	Patient	M	Used
Study	General Study	M	Used
	Patient Study	U	Used
Series	General Series	M	Used
Frame of Reference	Frame of Reference	U	Not Used
	US Frame of Reference	C	Not Used
Equipment	General Equipment	M	Used
Image	General Image	M	Used
	Image Pixel	M	Used
	Contrast/Bolus	C	Used if Contrast selected during acquisition
	Palette Color lookup table	C	Used when Photometric Interpretation has a value of PALETTE COLOR
	US Region Calibration	U	Used when calibration exists.
	US Image	M	Used
	Overlay Plane	U	Not Used
	VOI LUT	U	Not Used
	SOP Common	M	Used
Curve	Curve Identification	M	Not Used ³
	Curve	M	Not Used
	Audio	U	Not Used
	SOP Common	M	Not Used

Table 6: US Image IOD Modules

Each module has a table below indicating supported attributes and the attributes' source. Any special conditions pertaining to the listed elements will appear below the table. Note that an attribute is omitted from a Module table if it has already been discussed in a previous Module, unless it is augmented in the latter Module.

Attribute Name	Tag	Type	Description & Source
Patient's Name	(0010,0010)	2	Full name entered into patient ID screen of ultrasound system. NULL if no name entered.
Patient ID	(0010,0020)	2	Patient ID entered into patient ID screen of ultrasound system. NULL if no ID entered.
Patient's Birth Date	(0010,0030)	2	Patient DOB entered into patient ID screen of ultrasound system. NULL if not entered.
Patient's Sex	(0010,0040)	2	Patient sex entered into patient ID screen of ultrasound system. NULL if no sex entered.

Table 7: Patient Module Elements

Attribute Name	Tag	Type	Description & Source
Study Instance UID	(0020,000D)	1	Uniquely generated for each study

³ Curve IE is mutually exclusive with Image IE.

Attribute Name	Tag	Type	Description & Source
Study Date	(0008,0020)	2	System date setting at time study was acquired, if known. NULL if not known.
Study Time	(0008,0030)	2	System time setting at time study was acquired, if known. NULL if not known.
Referring Physician's Name	(0008,0090)	2	Physician entered into patient ID screen of ultrasound system. NULL if no name entered.
Study ID	(0020,0010)	2	NULL
Accession Number	(0008,0050)	2	NULL or Miscellaneous entered into Patient ID screen, if Configured

Table 8: General Study Module Elements

Attribute Name	Tag	Type	Description & Source
Patient's Age	(0010,1010)	3	Included if patient age or date of birth was entered in patient ID screen on system.
Patient's Size	(0010,1020)	3	Included if entered in patient ID screen.
Patient's Weight	(0010,1030)	3	Included if entered in patient ID screen.

Table 9: Patient Study Module Elements

Attribute Name	Tag	Type	Description & Source
Modality	(0008,0060)	1	US (Ultrasound)
Series Instance UID	(0020,000E)	1	Uniquely generated for each series. Images acquired under a "stress" protocol have a different value from non-stress images.
Series Number	(0020,0011)	2	NULL
Performing Physician's Name Operator's Name	(0008,1050) (0008,1070)	3	Sonographer entered into patient ID screen of ultrasound system. Omitted if no name entered.
Protocol Name	(0018,1030)	3	Description of the conditions under which the image was acquired. In the case of an image acquired during a stress exam, the Protocol Name describes the stress protocol used.
Series Description	(0008,103E)	3	"Indication" entered into patient ID screen of ultrasound system.

Table 10: General Series Attributes

Attribute Name	Tag	Type	Description & Source
Manufacturer	(0008,0070)	2	"Agilent-Technologies"
Institution Name	(0008,0080)	3	"Institution Name" entered into network utilities screen

Table 11: General Equipment Module Attributes

Attribute Name	Tag	Type	Description & Source
Performed Location	(0040,0243)	3	"Location" entered into patient ID screen of ultrasound system "

Table 12: Performed Procedure Step Information Module Attributes

Attribute Name	Tag	Type	Description & Source
Image Number	(0020,0013)	2	A number, unique within the study, identifying the image.
Patient Orientation	(0020,0020)	2C	NULL
Image Date	(0008,0023)	2C	Date image was acquired, if known; NULL otherwise.
Image Time	(0008,0033)	2C	Time image was acquired, if known; NULL otherwise.
Image Type	(0008,0008)	2	Value 1 = "DERIVED" if JPEG compressed image, "ORIGINAL" otherwise Value 2 = "SECONDARY" if the image was captured from VCR; "PRIMARY" otherwise.
Derivation Description	(0008,2111)	3	If this is a JPEG compressed image, this attribute contains a string indicating lossy JPEG and the quality measure from the network configuration screen; "ORIGINAL" otherwise.
Image Comments	(0020,4000)	3	Includes user-entered comment requested by the ultrasound system when the image is stored. For protocol images this will contain equipment generated or previously configured storage comments.

Table 13: General Image Storage Module Attributes

Attribute Name	Tag	Type	Description & Source
Samples Per Pixel	(0028,0002)	1	Value = 1 or 3. See Section 2.1.2.4.2.
Photometric Interpretation	(0028,0004)	1	See Section 2.1.2.4.2.
Rows	(0028,0010)	1	Number of pixel rows
Columns	(0028,0011)	1	Number of pixel columns
Bits Allocated	(0028,0100)	1	Value = 8 or 16. See Section 2.1.2.4.2.
Bits Stored	(0028,0101)	1	Value = Bits Allocated (8 or 16)
High Bit	(0028,0102)	1	Value = Bits Allocated - 1 (7 or 15)
Pixel Representation	(0028,0103)	1	0000H = unsigned integer
Pixel Data	(7FE0,0010)	1	Pixel data
Planar Configuration	(0028,0006)	1C	If Samples per Pixel is greater than 1, set to 000 = R1,G1,B1,R2,G2,B2,... Omitted otherwise.
Pixel Aspect Ratio	(0028,0034)	1C	Ratio of vertical pixel size to horizontal pixel size (V,H)
Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Included if using PALETTE_COLOR
Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Included if using PALETTE_COLOR
Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Included if using PALETTE_COLOR
Red Palette Color Lookup Table Data	(0028,1201)	1C	Included if using PALETTE_COLOR
Green Palette Color Lookup Table Data	(0028,1202)	1C	Included if using PALETTE_COLOR
Blue Palette Color Lookup Table Data	(0028,1203)	1C	Included if using PALETTE_COLOR

Table 14: Image Pixel Module Attributes

Attribute Name	Tag	Type	Description & Source
Contrast/Bolus Agent	(0018,0010)	2	Included if Contrast selected during acquisition

Table 15: Contrast/Bolus Module Attributes

Attribute Name	Tag	Type	Description & Source
Palette Color Lookup Table UID	(0028,1199)	3	Included if using PALETTE_COLOR

Table 16: Palette Color Lookup Module Attributes

Attribute Name	Tag	Type	Description & Source
Sequence of Ultrasound Regions	(0018,6011)	1	Defines a sequence of calibration regions
>Region Location Min x0	(0018,6018)	1	Upper left point of region where (x,y) = (0,0) is upper left corner of image.
>Region Location Min y0	(0018,601A)	1	
>Region Location Max x1	(0018,601C)	1	Lower right point of region where (x,y) = (0,0) is upper left corner of image.
>Region Location Max y1	(0018,601E)	1	
>Physical Units X Direction	(0018,6024)	1	Units in X direction which Physical Delta X and Ref. Pixel Physical Value X are measured in.
>Physical Units Y Direction	(0018,6026)	1	Units in Y direction which Physical Delta Y and Ref. Pixel Physical Value Y are measured in.
>Physical Delta X	(0018,602C)	1	Difference in physical value, in terms of above units, a move of 1 pixel in the positive X direction corresponds to.
>Physical Delta Y	(0018,602E)	1	Difference in physical value, in terms of above units, a move of 1 pixel in the positive Y direction corresponds to.
>Reference Pixel x ₀	(0018,6020)	3	Used in some waveform and spectral displays where an absolute pixel value in the region should be established.
>Reference Pixel y ₀	(0018,6022)		
>Ref. Pixel Physical Value X	(0018,6028)	3	Used in some waveform and spectral displays where an absolute pixel value in the region should be established.
>Ref. Pixel Physical Value Y	(0018,602A)	3	Used in some waveform and spectral displays where an absolute pixel value in the region should be established. This will be the Y value in "Physical Units Y Direction" units at the Reference Pixel.
>Region Spatial Format	(0018,6012)	1	Spatial organization of region data
>Region Data Type	(0018,6014)	1	Type of data within the region
>Region Flags	(0018,6016)	1	Transparent + Protected + Velocity or Transparent + Protected + Frequency

Table 17: US Region Calibration Module Attributes

Attribute Name	Tag	Type	Description & Source
Image Type	(0008,0008)	2	Values 3 and 4 = NULL
Number of Stages	(0008,2124)	2C	Included if this image is acquired as part of a protocol study.
Number of Views in Stage	(0008,212A)	2C	Included if this image is acquired as part of a protocol study.

Attribute Name	Tag	Type	Description & Source
Ultrasound Color Data Present	(0028,0014)	3	01 = ultrasound color data is present
Lossy Image Compression	(0028,2110)	1C	If JPEG compression is used, lossy compression is so indicated: 01 if JPEG transfer syntax used 00 if RLE or Little Endian transfer syntax used
Stage Name	(0008,2120)	3	Included if this image is acquired as part of a protocol study or while the protocol is paused within a protocol study.
Stage Number	(0008,2122)	3	Included if this image is acquired as part of a protocol study or while the protocol is paused within a protocol study.
View Number	(0008,2128)	3	Included if this image is acquired as part of a protocol study.
Number of Event Timers	(0008,2129)	3	Included if an event timer was used during image acquisition.
Event Elapsed Time(s)	(0008,2130)	3	Included if "Number of Event Timers" is not 0.
Event Timer Name(s)	(0008,2132)	3	Included if "Number of Event Timers" is not 0.
Heart Rate	(0018,1088)	3	Beats per minute, derived from ultrasound system ECG

Table 18: US Image Module Attributes

Attribute Name	Tag	Type	Description & Source
SOP Class UID	(0008,0016)	1	US Image Storage (1.2.840.10008.5.1.4.1.1.6.1)
SOP Instance UID	(0008,0018)	1	UID generated for each instance
Specific Character Set	(0008,0005)	1C	Present if one or more characters are not in the DICOM default character set. See Section 6.
Instance Creator UID	(0008,0014)	3	UID generated for each IDI device.

Table 19: SOP Common Module Attributes

2.1.2.4.2.2 Conformance for Ultrasound Multiframe Image Storage SOP Class

The C-STORE event will indicate an Ultrasound Multi-frame Image Storage SOP Class. The Ultrasound Multi-frame Image Storage SOP uses the Ultrasound Multi-frame Image IODs modules as follows

IE	Module	Required	Usage
Patient	Patient	M	Used
Study	General Study	M	Used
	Patient Study	U	Used
Series	General Series	M	Used
Frame of Reference	Frame of Reference	U	Not Used
	US Frame of Reference	C	Not Used
Equipment	General Equipment	M	Used
	General Image	M	Used
Image	Image Pixel	M	Used
	Contrast/Bolus	C	Used if Contrast selected during acquisition
	Cine	M	Used
	Multi-frame	M	Used

IE	Module	Required	Usage
	Palette Color lookup table	C	Used when Photometric Interpretation has a value of PALETTE COLOR
	US Region Calibration	U	Used when calibration exists.
	US Image	M	Used
	VOI LUT	U	Not Used
	SOP Common	M	Used
Curve	Curve Identification	M	Not Used ⁴
	Curve	M	Not Used
	Audio	U	Not Used
	SOP Common	M	Not Used

Table 20: US Multi-Frame Image IOD Modules

Additions and differences to module attributes from the US Image Storage SOP to the US Multi-frame Image Storage SOP as listed below. Omitted attributes and tables are expected to have the same implementation as the US Image Storage SOP.

Attribute Name	Tag	Type	Description & Source
Frame Time	(0018,1063)	1C	Time per frame (in msec) ⁵
Frame Time Vector	(0018,1065)	1C	Table of frame/frame times (in msec)
Recommended Display Frame Rate	(0008,2144)	3	Average frame rate over all frames in the multi-frame image.
Cine Rate	(0018,0040)	3	Average frame rate over all frames in the multi-frame image.

Table 21: Cine Module Attributes

Attribute Name	Tag	Type	Description & Source
Number of Frames	(0028,0008)	1	Number of frames in the image
Frame Increment Pointer	(0028,0009)	1	Reference to either “Frame Time” or “Frame Time Vector”

Table 22: Multi-Frame Module Attributes

Attribute Name	Tag	Type	Description & Source
SOP Class UID	(0008,0016)	1	US Multi-frame Image Storage (1.2.840.10008.5.1.4.1.1.3.1)

Table 23: SOP Common Module Attributes Modified for Multi-Frame

2.1.3 Association Acceptance Policy

Associations are only accepted by the Verification AE.

⁴ IE is mutually exclusive with Image IE.

⁵ The “Frame Time” attribute is standard for multi-frame images; “Frame Time Vector” may be configured to be used instead of Frame Time by a trained service person.

2.2 Print Agent AE Specification

2.2.1 Network Association Establishment Policy

2.2.1.1 General

Print Agent AE will utilize and understand the following Application Context Name:

DICOM V3.0 Application Context	1.2.840.10008.3.1.1.1
--------------------------------	-----------------------

Print Agent AE contains a limitation of 100Kbytes for maximum PDU size.

2.2.1.2 Number of Associations

Print Agent AE allows one association at any given time.

2.2.1.3 Asynchronous Nature

Print Agent AE allows a single outstanding operation on any association. Therefore, Print Agent AE does not support asynchronous operations window negotiation, other than the default as specified by the DICOM specification.

2.2.1.4 Implementation identifying information

Print Agent AE is identified as shown.

Element	Implementation Value
Implementation Class UID	1.2.124.113532.1.1
Implementation Version Name	“MITRA22JAN97”

Table 24: Print Implementation Identifying Information

2.2.2 Association Initiation by Real-World Activity

Print Agent AE initiates an association when the operator chooses the following activity:

- End Study

Request print image to a remote DICOM device.

2.2.2.1.1 Associated Real World Activity - Print

Print Agent AE will issue Print Management requests to an SCP supporting the DICOM V3.0

Print services, in order to produce hard copy representations of DICOM images.

2.2.2.1.2 Proposed Presentation Contexts - Print

Print Agent AE supports the following Presentation Contexts for **Print**.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Basic Film Session	1.2.840.10008.5.1.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Basic Film Box	1.2.840.10008.5.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Basic Grayscale Image Box	1.2.840.10008.5.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Basic Grayscale Print Management Meta	1.2.840.10008.5.1.1.9	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Basic Color Image Box	1.2.840.10008.5.1.1.4.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Basic Color Print Management Meta	1.2.840.10008.5.1.1.18	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Printer	1.2.840.10008.5.1.1.16	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

Table 25: Print Presentation Contexts

Print Agent AE provides standard conformance to the DICOM **Print** Service Class by supporting a number of distinct SOP classes described below.

2.2.2.1.2.1 SOP Specific Conformance to Basic Film Session SOP Class

Print Agent AE issues the following DIMSE-N commands for the Basic Film Session SOP Class:

N-CREATE

2.2.2.1.2.2 SOP Specific Conformance to Basic Film Box SOP Class

Print Agent AE issues the following DIMSE-N commands for the Basic Film Box SOP Class:

N-CREATE

N-ACTION

Print Agent AE supports only STANDARD formats (STANDARD\1,1; STANDARD\2,2, etc.) with details dependent upon the resolution and capabilities of printer.

2.2.2.1.2.3 SOP Specific Conformance to Basic Grayscale Image Box SOP Class

Print Agent AE issues the following DIMSE-N commands for the Basic Grayscale Image Box SOP Class:

N-SET.

2.2.2.1.2.4 SOP Specific Conformance to Basic Color Image Box SOP Class

Print Agent AE issues the following DIMSE-N commands for the Basic Color Image Box SOP Class:

N-SET.

2.2.2.1.2.5 SOP Specific Conformance to Printer SOP Class

Print Agent AE issues the following DIMSE-N commands for the Printer SOP Class:

N-GET.

2.2.2.1.2.6 SOP Specific Conformance to Basic Grayscale Print Management Meta SOP Class

The Meta SOP class is supported at negotiation, but is not implemented as the individual SOP classes defined by the DICOM specification.

2.2.3 Association Acceptance Policy

Print Agent AE does not accept association at any activated time.

2.3 Verification AE Specification

The Verification AE provides standard conformance to the DICOM SOP Class shown in Table 26. Note that the entity provides conformance for this service in the role of a SCU.

SOP Class Name	SOP Class UID	Role
----------------	---------------	------

Verification SOP Class	1.2.840.10008.1.1	SCU or SCP
------------------------	-------------------	------------

Table 26: SOP Class Supported by Verification AE

2.3.1 Association Establishment Policies

2.3.1.1 General

Maximum PDU size offered: 258,048 bytes, and is configurable.

2.3.1.2 Number of Associations

Up to two associations may be established at one time for this AE: one for implicit verification of server performed during system startup or server change, and another for the explicit verification of the server via user command.

2.3.1.3 Asynchronous Nature

Multiple outstanding transactions on a single association are not supported. Replies are handled for the current transaction before another may be initiated.

2.3.1.4 Implementation Identifying Information

The Verification AE has the same implementation identifying information as shown in section 2.1.1.4.

2.3.2 Association Initiation By Real-World Activity

2.3.2.1 Configure Network Real-World Activity

2.3.2.1.1 Associated Real-World Activity

There are two commands in the *Configure Network* activity that use the Verification Service. Each of these actions causes an association for the Verification SOP Class to be opened. A C-ECHO event is initiated to the chosen server, and the user is notified if a successful C-ECHO-RSP is received from the Verification SCP. These commands and the resultant IDI behavior are:

- 1) Changing the active server via the Network Utilities “SERVER” command. After any open storage association is closed, IDI attempts to verify the newly selected server before any further storage associations may be opened with that server.
- 2) Explicitly verifying a server via the Network Utilities “VERIFYSERVER” command. IDI attempts to verify the named server for a predetermined wait period, after which the user is informed whether or not the verification was successful.

2.3.2.1.2 Proposed Presentation Contexts

Only one association is established for each verification attempt. When the association is opened, the presentation contexts noted in Table 27 are proposed.

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Verification SOP Class	1.2.840.10008.1.1	Explicit VR Little Endian	1.2.840.10008.1.2.1	SCU	None
		Implicit VR Little Endian	1.2.840.10008.1.2		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

Table 27: Proposed Presentation Contexts

2.3.2.1.2.1 Conformance for Verification SOP Class

The C-ECHO request primitive is sent to the Verification SCP. The C-ECHO response primitive is returned by the Verification SCP with a status indicator of success. The absence of a C-ECHO response within a specific timeout period is an indication that the server cannot be located through the Verification service.

2.3.2.2 Start System Real-World Activity

When IDI is started, IDI attempts to verify the presence of the configured server through the verification service. An association is opened and a C-ECHO event is initiated to the chosen server. If the chosen server does not accept the association or if the association is accepted but the server does not respond with a C-ECHO response of “success”, then the operation is periodically repeated until this condition is met before continuing with storage activity.

Refer to Section 2.3.2.1, “*Configure Network Real-World Activity*” for the behavior of this service.

2.3.3 Association Acceptance Policy

2.3.3.1 Real World Activity - Verification

2.3.3.1.1 Associated Real World Activity - Verification

IDI will respond to *external Verification* requests to provide an SCU with the ability to determine if IDI is receiving DICOM requests.

2.3.3.1.2 Presentation Context Table - Verification

IDI will accept for the Verification SOP Class any of the Presentation Contexts listed in Table 27.

2.3.3.1.3 SOP Specific Conformance - Verification

IDI provides standard conformance to the DICOM Verification Service Class. IDI returns the following status code.

Condition	Status Codes	Description
-----------	--------------	-------------

Condition	Status Codes	Description
Success	0000	Operation performed properly.

Table 28: Verification status codes.

2.3.3.1.4 Transfer Syntax Selection Policies - Verification

Since no DICOM data object is associated with a Verification command, only the uncompressed DICOM transfer syntaxes are required and supported.

3 Communications Profiles

The Integrated Digital Interface conforms to the DICOM Application Context 1.2.840.10008.3.1.1.1.

3.1 Supported Communication Stacks

Provides DICOM V3.0 TCP/IP Network Communication Support.

3.2 TCP/IP Stack

TCP/IP networking protocol is used, with static IP addressing. Name resolution, if desired, may be accomplished through a variety of mechanisms including DNS, WINS, NetBIOS name resolution, and LMHOSTS file lookup, or may be avoided entirely through the direct entry of the remote host's IP address.

3.2.1 Physical Media Support

10BaseT and 100BaseT are supported.

3.2.2 Communication Timeouts and Wait Periods

Network timeouts are preselected to be appropriate to a large range of network configurations, including:

“Association and Release” (DICOM “ARTIM”)	The time to use as a time out waiting for an association request or waiting for the peer to shut down an association. Set to 120 seconds.
“Connect”	The time to wait for a network connect to be accepted. Set to 240 seconds.
“Association Reply”	The time to wait for a reply to an associate request. Set to 120 seconds.
“Release”	The time to wait for a reply to an associate release. Set to 120 seconds.
“Write”	The time to wait for a network write operation to be accepted. Set to 120 seconds.

“Inactivity”	The time to wait for successive TCP/IP data packets when reading a message from the SCP. Set to 120 seconds.
Printer Timeout	Printer Association-negotiation time-out. Default is 120 seconds.

Should an association be aborted or closed as part of network error detection and recovery (see section 2.1.2.4.1 Associated Real-World Activity), IDI waits for a period of 180 seconds before attempting to reestablish the association and retry the failed message.

4 Extensions/Specializations/Privatizations

4.1 Standard Extended / Specialized / Private SOPs

This implementation extends the Standard Ultrasound Image and Multiframe Image SOP class, by the addition of the element detailed in Table 12: Performed Procedure Step Information Module Attributes

4.2 Private Transfer Syntaxes

No private transfer syntaxes have been implemented.

5 Configuration

5.1 AE Title / Presentation Address Mapping

Mapping from AE Title to Presentation Address is achieved through the Network Utilities configuration (see section 5.2.1). Each remote AE is defined by specifying the server name or IP address, the TCP port number, and the Application Entity Title. If a server name is provided, an appropriate mapping mechanism of name to IP address must be provided using available Windows/NT network configuration capabilities.

5.2 Configurable Parameters

5.2.1 Network Utilities User Interface

Configuration options are set through the Resident Self-Test Network Utilities Screen on the ultrasound system. DICOM-specific network parameters include:

- IDI network configuration parameters, including IP address, subnet mask, and default gateways
- IDI’s AE Title
- Institution Name to be included as an attribute value in each DICOM image.

- Specification of DICOM server (SCP) addresses:
 - Server Name or IP address
 - TCP/IP Port Number
 - AE Title
 - C-STORE Response timeout in seconds (default = 1800 seconds)

5.2.2 Network Storage Configurable Parameters

- Server selection (for the Network Storage AE and implicit Verification AE events)
- Compression of transferred images. Compression for single frame and multi-frame images is configured separately. Choices include:
 - Lossy JPEG compressed (with JPEG "quality factor")
 - Lossless RLE compression
 - No compression (Implicit VR Little Endian transfer syntax)
- PDU maximum length and related TCP send/receive buffer sizes.
- Monochrome switch: if set, causes color images to be sent as MONOCHROME2.
- Patient ID Miscellaneous switch: if set, causes Accession Number to be sent from the Miscellaneous field in Patient ID screen.

5.2.3 Print Agent Configuration

The Print Agent itself does not configure parameters it requires, instead it relies on its host application or host system to maintain configuration parameters of local and remote DICOM application entities. The parameters are as follows:

- Application Entity Title (AE Title) : use host application's AE title
- Host Name for the AE Title : use host application's host name
- Port Number for the AE Title : 104
- Alias for the AE Title : use host application's host name
- Packet Size for the AE Title : 16000 default
- IP Address for the AE Title : host machine IP address

6 Support of Extended Characters

If a DICOM image contains one or more characters not contained within the DICOM default character set, the Latin alphabet, No.1 extended character set ISO-8859-1, Part 1 is designated via the Specific Character Set attribute;

otherwise this attribute is omitted and the image can be assumed to contain only characters in the DICOM default character set.

Print Agent supports the following character sets:

- ISO-IR 100 (Latin alphabet No.1) Supplementary set of ISO 8859

7 DIMSE-Service and Attributes - Print

7.1 DIMSE-Services

Table 29

SOP Class	DIMSE Service Element	Reference	Usage SCU ¹
Basic Film Session SOP Class	N-CREATE	8.2.1	M
	N-SET	Not used	U
	N-DELETE	Not used	U
	N-ACTION	Not used	U
Basic Film Box SOP Class	N-CREATE	8.3.1	M
	N-SET	Not used	U
	N-DELETE	Not used	U
	N-ACTION	Used	M
Image Box SOP Class	N-SET	8.4.1 8.5.1	M
Printer SOP Class	N-EVENT-REPORT	Not used	M
	N-GET	Used	U

¹ M = Mandatory, U = User option

7.2 Basic Film Session SOP Class

7.2.1 N-CREATE Attributes

Table 30

Attribute Name	Tag	Usage	Attribute Description	
			Options	Default
Number of Copies	(2000,0010)	U	[1 to 99]	1
Print Priority	(2000,0020)	U	LOW MED HIGH	MED
Medium Type	(2000,0030)	U	PAPER CLEAR FILM BLUE FILM	PAPER
Film Destination	(2000,0040)	U	PROCESSOR MAGAZINE	PROCESSOR

			BIN_i	
Film Session Label	(2000,0050)	U	Not Set	Not Set
Memory Allocation	(2000,0060)	U	Not set	Not set

7.3 Basic Film Box SOP Class

7.3.1 N-CREATE Attributes

Table 31

Attribute Name	Tag	Usage	Attribute Description	
			Options	Default
Image Display Format	(2010,0010)	M	STANDARD\cols,rows	STANDARD\2,3
Film Orientation	(2010,0040)	U	PORTRAIT LANDSCAPE	PORTRAIT
Film Size ID	(2010,0050)	U	8INX10IN, 8_5INX11IN, 10INX12IN, 10INX14IN, 11INX14IN, 11INX17IN, 14INX14IN, 14INX17IN, 24CMX24CM, 24CMX30CM, A3, A4, ...	8INX10IN
Magnification Type	(2010,0060)	U	NONE, BICUBIC, BILINEAR, CUBIC, LANCZOS, MITCHELL, REPLICATE, ...	CUBIC
Border Density	(2010,0100)	U	BLACK, WHITE or a density number: 0-399	BLACK
Empty Image Density	(2010,0110)	U	BLACK, WHITE or a density number: 0-399	BLACK
Trim	(2010,0140)	U	YES, NO	YES
Min Density	(2010,0120)	U	0-399	[empty]
Max Density	(2010,0130)	U	0-399	[empty]
Configuration Information	(2010,0150)	U	[Text string] Vendor specific information	Not apply if this field is empty or missing
Annotation display format ID	(2010,0030)	U	[Text string]	[empty] Not apply if this field is empty or missing
Referenced Film Session Sequence	(2010,0500)	M	Always set	
>Referenced SOP Class UID	(0008,1150)	M	Always set	
>Referenced SOP Instance UID	(0008,1155)	M	Always set	

7.4 Basic Grayscale Image Box SOP Class

7.4.1 N-SET Attributes

Table 32

Attribute Name	Tag	Usage	Attribute Description	
			Options	Default
Image Position	(2020,0010)	M	Always set	
Polarity	(2020,0020)	U	NORMAL REVERSE	NORMAL
Magnification Type	(2010,0060)	U	NONE, BICUBIC, BILINEAR, CUBIC, LANCZOS, MITCHELL, REPLICATE, ...	CUBIC
Smoothing Type	(2010,0080)	U	NORMAL, ENHANCED, ... Note: This parameter is valid and applied only if MagnificationType is CUBIC	NORMAL
Basic Grayscale Image Sequence	(2020,0110)	M	Always set	
>Samples Per Pixel	(0028,0002)	M	Always set (1)	
>Photometric Interpretation	(0028,0004)	M	Always set	
>Rows	(0028,0010)	M	Always set	
>Columns	(0028,0011)	M	Always set	
>Pixel Aspect Ratio	(0028,0034)	M	Always set	
>Bits Allocated	(0028,0100)	M	Always set (8)	
>Bits Stored	(0028,0101)	M	Always set (8)	
>High Bit	(0028,0102)	M	Always set (7)	
>Pixel Representation	(0028,0103)	M	Always set (0)	
> Window Center	(0028,1050)	U	[string value] Apply only when photometric interpretation is either MONOCHROME1 or MONOCHROME2	[empty] Not apply if either window center or window width is empty or missing
> Window Width	(0028,1051)	U	[string value] Apply only when photometric interpretation is either MONOCHROME1 or MONOCHROME2	[empty] Not apply if either window center or window width is empty or missing
>Pixel Data	(7FE0,0010)	M	Always set	

7.5 Basic Color Image Box SOP Class

7.5.1 N-SET Attributes

Table 33

Attribute Name	Tag	Usage	Attribute Description	
			Options	Default
Image Position	(2020,0010)	M	Always set	
Polarity	(2020,0020)	U	NORMAL REVERSE	NORMAL
Magnification Type	(2010,0060)	U	NONE, BICUBIC, BILINEAR, CUBIC, LANCZOS, MITCHELL, REPLICATE, ...	CUBIC
Smoothing Type	(2010,0080)	U	NORMAL, ENHANCED, ... Note: This parameter is valid and applied only if MagnificationType is CUBIC	NORMAL
Basic Color Image Sequence	(2020,0111)	M	Always set	
>Samples Per Pixel	(0028,0002)	M	Always set (3)	
>Photometric Interpretation	(0028,0004)	M	Always set	
>Planar Configuration	(0028,0006)	M	Always set (0)	
>Rows	(0028,0010)	M	Always set	
>Columns	(0028,0011)	M	Always set	
>Pixel Aspect Ratio	(0028,0034)	M	Always set	
>Bits Allocated	(0028,0100)	M	Always set (8)	
>Bits Stored	(0028,0101)	M	Always set (8)	
>High Bit	(0028,0102)	M	Always set (7)	
>Pixel Representation	(0028,0103)	M	Always set (0)	
>Pixel Data	(7FE0,0010)	M	Always set	

7.6 Printer SOP Class

7.6.1 N-GET Attributes

Table 34

Attribute Name	Tag	Usage SCU/SCP
Printer Status	(2110,0010)	U/M
Printer Status Info	(2110,0020)	U/M
Printer Name	(2110,0030)	U/U

Manufacturer	(0008,0070)	U/U
Manufacturer's Model Name	(0008,1090)	U/U
Device Serial Number	(0018,1000)	U/U
Software Version	(0018,1020)	U/U

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