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REVISION STATUS	A B C	Initial Release Additions: VOI LUT; magnification type; birth date; image type; institution name, New SOPs, pixel interleave planar configuration, include lossy image compression tag. Corrections: Association 'keep-alive', film sizes supported. Document relayout. Added Modality Work List Support, Explicit Little Endian VR for Storage, and missing US Region Calibration Module, re-organized Storage section Tag and Type fields; changed Patient Name field detail, changed Patient ID field length, added Patient Sex entries.	SEE PIMS FOR EFFECTIVITY, REVISION & RELEASE STATUS

DOCUMENT TITLE

HDI 5000 DICOM Conformance Statement


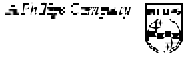
DOCUMENT PURPOSE:

The purpose of this document is to specify the DICOM conformance of the ATL HDI 5000, software version 170.30, Level 10.2.

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0. Introduction

This document describes the ATL HDI® 5000 Ultrasound System's conformance to the ACR-NEMA DICOM (Digital Imaging and Communications in Medicine) standard and satisfies the DICOM requirement for a vendor conformance specification.

The HDI 5000 system is an ultrasound imaging device. The NetLink option of the HDI 5000 system provides a means to send images to DICOM storage servers and printers, and to query Modality Worklist servers.

0.1 *DICOM Background*

The DICOM information exchange specification provides a definitive structure of commands and information that allow for the inter-communication of medical imaging devices. Developed by the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA), the DICOM standard strives to promote communication of image information through the use of a standardized set of command classes and information semantics.

The DICOM standard defines classes of information that are common to many modalities of medical imaging. However, to meet the specific needs of information content for such a diverse range of information, the DICOM specification defines structures for a multitude of medical data. To alleviate the need for applications to implement every aspect of the DICOM specification, a list of conformance tables for every modality was created to define the minimum set of information necessary for data exchanges. A requirement of the DICOM specification is to maintain a compliance document that outlines a subset of DICOM services and data classes that are supported by an application. The purpose of this document is to define a subset of DICOM for the exchange of information with the ATL HDI 5000 via its NetLink feature.

This document is written with respect to the ACR-NEMA Digital Imaging and Communications in Medicine (DICOM) version number 3.0.

1. Implementation Model

The HDI 5000 NetLink feature incorporates the DICOM 3.0 standard for networked image printing, image store and Modality Worklist query functions. Exam requests are returned from the Modality Worklist server that allows the operator to select which exam request to perform. The data returned from the query includes patient demographic data that the operator is not required to enter manually. Additional patient information from the Modality Worklist server is passed on the storage server with the associated images. Images are transferred from the HDI 5000 ultrasound system using standard network connections to be processed on a centralized printer or stored on a DICOM compatible file server.

1.1 Application Data Flow Diagram

The diagram below represents the relationship between Ultrasound system's real-world activities (in circles) that invoke of the NetLink device's Application Entity's local use of DICOM on the left side, and depicts the remote DICOM destination AE's on the right side. All Application Entities are in boxes.

Printing

When the user selects a New Patient via the Patient Data Entry facility, the Printing AE will initiate separate associations to the print servers to verify their on-line status. When selecting a device, the association created to check on-line status is closed when completed. When Patient Data entry is completed, another association is made, which is also closed. When the exam is started and the first image is sent, these associations remain open during the remainder of the examination. When Print is commanded (and depending upon the system configuration), the Printing AE will send an image to the appropriate printer. The N_Get Printer SOP is used automatically every two minutes during the exam to ensure that the print servers remain on-line during this time. When the End Exam command is invoked, any partially filled sheet of film is printed and then the associations are closed.

Storing

Also, when the user selects a New Patient via the Patient Data Entry facility, the Storing AE will initiate a separate association to each selected storage server to verify its on-line status. This initial association is closed. The end of Patient Data Entry will repeat the process, also closing the associations. When the first image is sent, another association is made, verified, then the associations remain open during the exam. When the user selects Store Image, the Storing AE sends the image to the server. When the End Exam command is invoked the association is closed.

Modality Worklist

(MWL) may be configured to query the MWL server invoked automatically on power up, at preset intervals, and / or at user discretion. The MWL SCU AE will initiate a Basic Worklist Service Class DIMSE-C C-FIND to query the MWL SCP for matching key attributes based on the settings for Station Name, Location and / or Application Entity Title. The association will be opened for the query, and closed when the results are returned.

A C-ECHO (for Storage and Worklist Devices), or N_GET Status (for Print devices) are issued upon completion of power up when network devices are already selected in the system. These associations are created and closed when the response is complete.

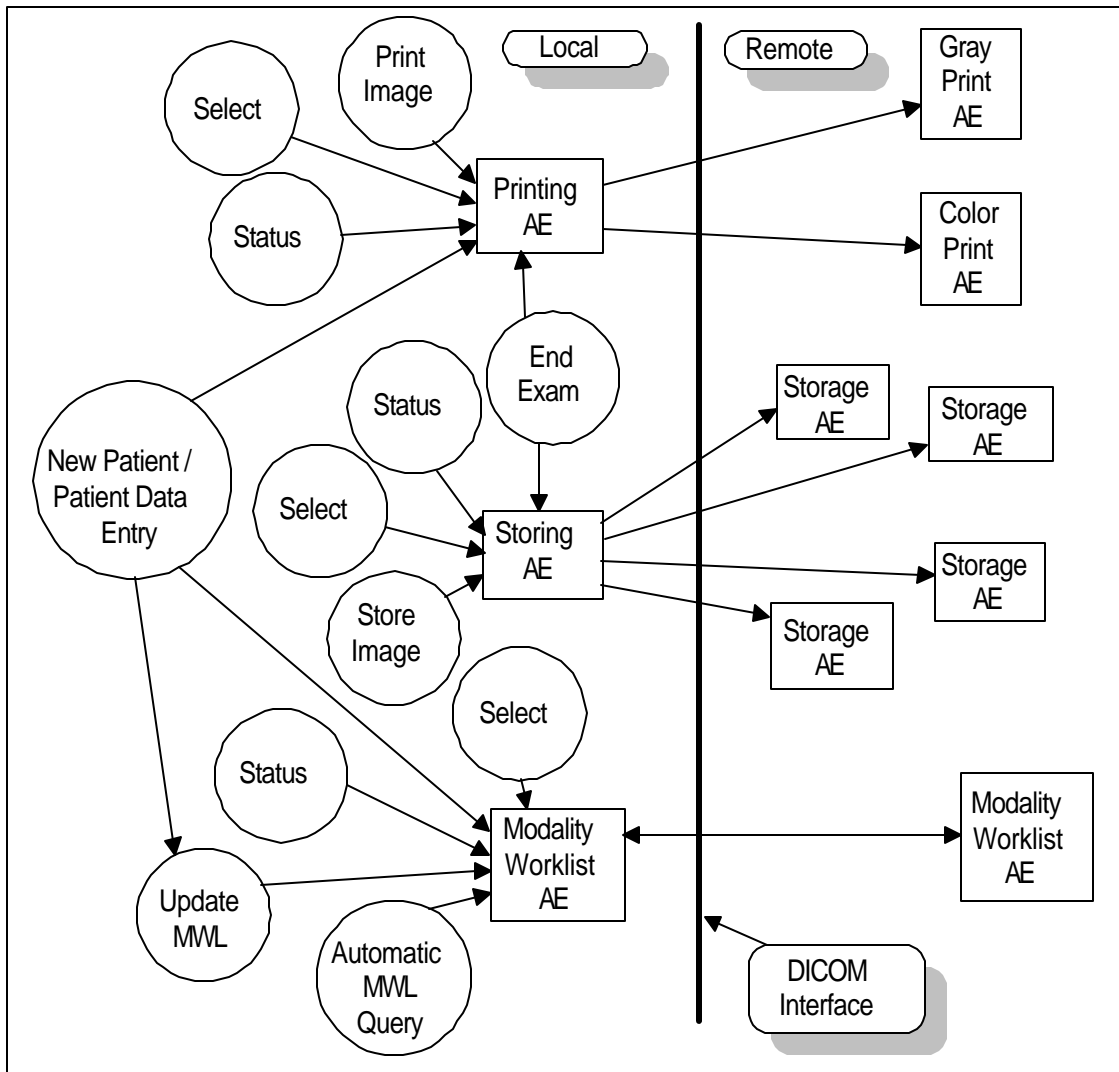
The following tables describe Association Negotiation and Association status for each group of DICOM services supported by the HDI 5000:

TABLE 1.1-1 ASSOCIATION NEGOTIATION - ASSOCIATION STATUS

User Action	DICOM Activity - Store	DICOM Activity - Print
Select Device	Association Negotiation, C-ECHO, then Association Release Request	Association Negotiation + N-Create Film Session and N_Create Film Box, N_GET Status then two N_Deletes , Association Release Request
Complete Patient Data Entry	Association Negotiation, C-ECHO, then Association Release Request	Association Negotiation + N-Create Film Session and N_Create Film Box, N_GET Status then two N_Deletes , Association Release Request
First data sent from system	Association Negotiation, C-ECHO then C-Store until End Exam when Association Release Request is sent.	Association Negotiation + N-Create Film Session and N_Create Film Box, N_GET Status then N_Sets for each image and N_Action for each page and End of Exam, then Association Release Request

TABLE 1-1.2 MODALITY WORKLIST ASSOCIATION BEHAVIOR

User Action	DICOM Activity - Modality Worklist Device Association
Select Device	Association Negotiation, C-ECHO, then Association Release Request
System Auto Query	Association Negotiation, C-ECHO followed by a C-FIND for selected query attributes. After transfer of responses, Association Release Request
Manual / User Query	Association Negotiation, C-ECHO followed by a C-FIND for selected query attributes. After transfer of responses, Association Release Request



The Print, Store and Modality Worklist AE's share the same AE title.

Note: The Status command initiates a Verify to the selected Storage and Modality Worklist SCPs. Printers are sent the N_Get Status command to

1.2 Functional Definitions of AE's

Printing AE

This AE handles all aspects of the Print Management SCU. The remote SCP must support the Verification SOP Class.

Storing AE

This AE handles sending ultrasound images to a storage server using the DICOM Store SCU Services. The remote SCP must support the Verification SOP Class.

Modality Worklist AE

This AE handles querying the Modality Worklist server as an SCU using the DICOM Basic Modality Worklist Service Class DIMSE-C C-FIND service. It will locate and retrieve study requests that match user defined criteria. The remote SCP must support Verification SOP Class as well.

1.3 Sequencing of Real-World Activities

For printing and storing using the Print Gray Image, Print Color Image, and Store Image commands, an association must have been previously opened using the New Patient command. The destination device(s) must have successfully responded to the N_Get Status (printers) or Verification SOP class (storage and Modality Worklist) prior to use.

An association for Modality Worklist will be made when the automatic or user initiated query is executed.

Associations may also be initiated in certain circumstances upon system power up or connection to the network.

2. AE Specifications

2.1 Printing AE - Specification

The Printing AE provides conformance to the following DICOM SOP Classes as an SCU:

SOP Class Name	SOP Class UID	Conformance Level
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	Standard
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18	Standard
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1	Standard
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2	Standard
Basic Gray Image Box SOP Class	1.2.840.10008.5.1.1.4	Standard
Basic Color Image Box SOP Class	1.2.840.10008.5.1.1.4.1	Standard
Printer SOP Class	1.2.840.10008.5.1.1.16	Standard
Verification SOP Class	1.2.840.10008.1.1	Standard

2.1.1 Association Establishment Policies

The Printing AE will initiate an association when the user invokes the New Patient / Patient Data Entry command. The Gray and Color SOP Print Management Service Class connections will be done on separate associations. The N_Get Printer SOP will be used to verify that an association is still active even though no printing is taking place.

2.1.1.1 General

Maximum PDU size offered: 32,768 bytes

Minimum PDU size accepted: 1,024 bytes

2.1.1.2 Number of Associations

Number of simultaneous associations for the Printing AE:

- 1 for Gray Print Management
- 1 for Color Print Management

Note that the other Application Entities in this device may be simultaneously active and thus other associations may be open simultaneously with these.

2.1.1.3 Asynchronous Nature

The Printing AE will not use asynchronous operations.

2.1.1.4 Implementation Identifying Information

Implementation Class UID: "1.2.840.113663.1"

Implementation Version name: "Tiller_v101"

Notes: "113663" is registered by ATL with ANSI. Version name above will be used initially but is subject to change with versions.

2.1.2 Association Initiation by: Real-World Activity

The Printing AE will open associations to the Gray Print Server and to the Color Print Server when the real-world activity occurs corresponding to the user invocation of New Patient or Select Printer.

2.1.2.1 Association Initiation by: New Patient

The user invocation of New Patient will cause separate associations to be initiated to a Gray Print Server and a Color Print Server. These two associations may actually be handled by one device but are managed separately by the Printing AE.

2.1.2.2 Association Initiation by: Select Printer

The user invocation of Select Printer will initiate an association to the Print Server followed by an N-GET for printer status.

2.1.3 Proposed Presentation Context to a Gray Print Server

TABLE 2.1.3 –1 PRINTING AE PROPOSED PRESENTATION CONTEXTS TO A GRAY PRINT SERVER

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Basic Gray Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None
Verification SOP Class	1.2.840.10008.1.1	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None

2.1.3.1 SOP Specific Conformance to Verification SOP Class

The Printing AE requires the Verification SOP Class as an SCU. The remote SCP must support the Verification SOP Class.

2.1.3.2 SOP Specific Conformance to Basic Gray Print Management Meta SOP Class

The Printing AE provides Standard Conformance to the Basic Gray Print Management Meta SOP Class as an SCU. This implies standard conformance for the

- Basic Film Session SOP Class,
- Basic Film Box SOP Class,
- Basic Grayscale Image Box SOP Class,
- Printer SOP Class.

Each of these SOP classes is described in the paragraphs to follow.

2.1.3.3 SOP Specific Conformance to Basic Film Session SOP Class

DICOM specified usage: M = Mandatory, U = User option

Supported DIMSE Services

Name	Usage	Description
N-Create	M	Creates the film session
N-Set	U	Not used
N-Delete	U	Deletes the film session
N-Action	U	Not used

Supported SOP Class Elements

Name	Usage	Range	Description
Number of Copies	U	1 to many	Number of requested copies of film
Print Priority	U	MED	Used
Medium Type	U	Paper Clear Film Blue Film	Printer may further restrict range.
Film Destination	U	Magazine Processor	Printer may further restrict range.
Film Session Label	U	--	Not used
Memory Allocation	U	--	Not used

2.1.3.4 SOP Specific Conformance to Basic Film Box SOP Class

Supported DIMSE Services

Name	Usage	Description
N-Create	M	Creates the film box.
N-Set	U	Not used
N-Delete	U	Deletes the film box. Used after each film is printed.
N-Action	M	PRINT. Sent after each filling of a film box and also at the end of the exam if one or more images have been transferred into the film box.

Supported SOP Class Elements

Name	Usage	Range	Description
Image Display Format	M	Standard \ 1,1 Standard \ 1,1 Standard \ 1,2 Standard \ 2,1 Standard \ 2,3 Standard \ 3,2 Standard \ 3,3 Standard \ 3,3 Standard \ 3,4 Standard \ 4,3 Standard \ 3,5 Standard \ 5,3 Standard \ 4,5 Standard \ 5,4 Standard \ 5,6 Standard \ 6,5	Printer may further restrict range.
Referenced Film Session Sequence	M		Used
Referenced SOP Class UID	M	1.2.840.10008.5.1.1.1	Film Session SOP Class UID
Referenced SOP Instance UID	M		Referenced Film Session SOP
Film Orientation	U	Portrait Landscape	Printer may further restrict range.
Film Size ID	U	8 in X 10 in 14 in X 14 in 10 in X 12 in 14 in X 17 in 10 in X 14 in 24 cm X 24 cm 11 in X 14 in 24 cm X 30 cm 11 in X 17 in 35 cm X 43 cm 12 in X 18 in	Printer may further restrict range.
Magnification Type	U	Configurable	None, Bilinear, Cubic, Bicubic, Mitchell, Lanczos, Replicate
Max Density	U	Limited by printer	Used
Configuration Information	U	Limited by printer	Used
Annotation Display Format Id	U		Not used
Smoothing Type	U		Not used
Border Density	U	Dmin to Dmax	Used
Empty Image Density	U	Dmin to Dmax	Used
Min Density	U	Limited by printer	Used
Trim	U		Not used

2.1.3.5 SOP Specific Conformance to Basic Grayscale Image Box SOP Class

Supported DIMSE Services

Name	Usage	Description
N-Set	M	An image box instance is created by the SCP for each potential image of the film box. Only the instances that will actually contain images will be updated with the N_SET message.

Supported SOP Class Elements

Name	Usage	Range	Description
Image Position	M	1-n	Used
Pre-formatted Grayscale Image Sequence	M		Used
Samples/pixel	M	1	Used
Photometric Interpretation	M	MONOCHROME2	0 = black, 255 = white
Rows	M	476 (NTSC), 576 (PAL)	pixels
Columns	M	640 (NTSC), 768 (PAL)	pixels
Pixel Aspect Ratio	M	68/68 (NTSC);82/82 (PAL)	
Bits Allocated	M	8	8 bits per sample

Bits Stored	M	8	Used
High bit	M	7	Bit 7 is MSB
Pixel Representation	M	0	Unsigned pixel values
Pixel Data	M		gray pixel data
Polarity	U		Not used
Referenced Overlay Sequence	U		Not used
>SOP Class UID	U		Not used
>SOP Instance UID	U		Not used
Magnification Type	U	Configurable	Used
Smoothing Type	U		Not used
Requested Image Size	U		Not used

2.1.3.6 SOP Specific Conformance to Printer SOP Class

Supported DIMSE Services

Name	Usage	Description
N-Event-Report	M	Handled but always ignored. Asynchronous input from the printer to this AE used to report changes in printer status. It may be received any time after association establishment and before association release or abort.
N-Get	U	May be issued by this device at any time to get printer status. The Attribute Identifier List will always be empty indicating that all attributes are to be returned.

Supported SOP Class Elements

Note: This device does not set these attributes. The attribute description here indicates which attributes this device uses when they are returned by the printer.

Name	Usage	Range	Description
Printer Status	U	NORMAL WARNING FAILURE	Warning and Failure are reported to user.
Print Status Info	U		Reported to user.
Printer Name	U		Ignored
Manufacturer	U		Ignored
Model Name	U		Not used
Serial Number	U		Not used
Software Version	U		Not used
Calibration Date	U		Not used
Calibration Time	U		Not used

2.1.4 Proposed Presentation Context to a Color Print Server

TABLE 2.1.2.1.2-1 PRINTING AE PROPOSED PRESENTATION CONTEXTS TO A COLOR PRINT SERVER

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None
Verification SOP Class	1.2.840.10008.1.1	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None

2.1.4.1 SOP Specific Conformance to Verification SOP Class

The Printing AE requires the Verification SOP Class as an SCU. The remote SCP must support the Verification SOP Class.

2.1.4.2 SOP Specific Conformance to Basic Color Print Management Meta SOP Class

The Printing AE provides Standard Conformance to the Basic Color Print Management Meta SOP Class as an SCU. This implies standard conformance for the following SOP classes:

Basic Film Session SOP Class

Basic Film Box SOP Class

Basic Color Image Box SOP Class

Printer SOP Class

Only the SOP classes specific to Color are described in the sections that follow. Otherwise, the Color Print Management Meta SOP Class uses the same general Printer and Film SOP classes as Grayscale.

2.1.4.3 SOP Specific Conformance to Basic Color Image Box SOP Class

Supported DIMSE Services

Name	Usage	Description
N-Set	M	An image box instance is created by the SCP for each potential image of the film box. Only the instances that will actually contain images will be updated with the N_SET message.

Supported SOP Class Elements

Name	Usage	Range	Description
Image Position	M	1-n	Used
Pre-formatted Color Image Sequence	M		Used
Samples/pixel	M	3	Used
Photometric Interpretation	M	RGB	Used
Planar Configuration	M	1	Planar—red plane first, then green, and blue.
Rows	M	476 (NTSC), 576 (PAL)	Pixels
Columns	M	640 (NTSC), 768 (PAL)	Pixels
Pixel Aspect Ratio	M	68/68 (NTSC), 82/82 (PAL)	
Bits Allocated	M	8	8 bits per sample
Bits Stored	M	8	Used
High bit	M	7	Bit 7 is MSB
Pixel Representation	M	0	Unsigned pixel values
Pixel Data	M		color pixel planes data
Polarity	U		Not used
Referenced Overlay Sequence	U		Not used
>SOP Class UID	U		Not used
>SOP Instance UID	U		Not used
Magnification Type	U	Configurable	Used
Smoothing Type	U		Not used
Requested Image Size	U		Not used

2.2 Storing AE - Specification

The Storing AE provides conformance to the following DICOM SOP Classes as an SCU:

SOP Class Name	SOP Class UID	Conformance Level
Verification SOP Class	1.2.840.10008.1.1	Standard
Ultrasound Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.6.1	Standard
Ultrasound Image Storage SOP Class (retired)	1.2.840.10008.5.1.4.1.1.6	Standard
Ultrasound MultiFrame Image SOP Class	1.2.840.10008.5.1.4.1.1.3.1	Standard
Ultrasound MultiFrame Image SOP Class (retired)	1.2.840.10008.5.1.4.1.1.3	Standard

Note: the choice of retired or retired or new SOP Class is configurable.

2.2.1 Association Establishment Policies

When the system is configured to “store during exam” the Storing AE will initiate an association when the user invokes the New Patient command. When configured to “store at end of exam,” the system will open the association at the end of the exam, transfer the entire study, then close the association. If an error occurs and the connection is broken, the system will periodically reattempt association to transfer the remaining data, even after the occurrence of a power cycle.

2.2.1.1 General

Maximum PDU size offered: 32,768 bytes

Minimum PDU size accepted: 1,024 bytes

2.2.1.2 Number of Associations

Number of simultaneous associations: 4

Note that the other Application Entities in this device may also be simultaneously active.

2.2.1.3 Asynchronous Nature

The Storing AE will not use asynchronous operations.

2.2.1.4 Implementation Identifying Information

Implementation Class UID: “1.2.840.113663.1”

Implementation Version name: “Tiller_v101”

Notes: “113663” is registered by ATL with ANSI. Version name above will be used initially but is subject to change with versions.

2.2.2 Association Initiation by: Real-World Activity

The Storing AE will open an association to the Storage Server when the real-world activity occurs corresponding to the user invocation of New Patient or Select Storage Server.

2.2.2.1 Association Initiation by: New Patient

The user invocation of New Patient will cause an association to be initiated to a Storage Server.

2.2.2.2 Association Initiation by: Select Storage Server

The user invocation of Storage Server will cause an association to be initiated to a Storage Server.

2.2.3 Proposed Presentation Context to a Storage Server

The presentation context is configurable from the SOPs in the following table. Any combination of Storage SOP Classes plus Verification may be configured via the associated device file. The system will only request the SOP Classes enabled therein. Therefore the Proposed Presentation Contexts are configuration dependent.

TABLE 2.2.3-1 STORING AE PROPOSED PRESENTATION CONTEXTS TO A STORAGE SERVER

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Verification SOP Class	1.2.840.10008.1.1	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	Any in Table 2.2.3-2	Any in Table 2.2.3-2	SCU	None
Ultrasound Image Storage (retired)	1.2.840.10008.5.1.4.1.1.6	Any in Table 2.2.3-2	Any in Table 2.2.3-2	SCU	None
Ultrasound Multiframe Image	1.2.840.10008.5.1.4.1.1.3.1	Any in Table 2.2.3-2	Any in Table 2.2.3-2	SCU	None
Ultrasound Multiframe Image Storage (retired)	1.2.840.10008.5.1.4.1.1.3	Any in Table 2.2.3-2	Any in Table 2.2.3-2	SCU	None

TABLE 2.2.3-2 STORAGE AE TRANSFER SYNTAX TABLE

Transfer Syntax Options	
Name List	UID List
DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2
DICOM Explicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2.1

2.2.3.1 SOP Specific Conformance to Verification SOP Class

The Storing AE provides standard conformance to the Verification SOP Class as an SCU. The remote SCP must support the Verification SOP Class on the same Association as the Storage SOP Class.

2.2.3.2 SOP Specific Conformance to Ultrasound Image Storage SOP Class

Note: The Modality Worklist implementation will add data to specific tags in various modules within the Ultrasound Image IOD. These additions are listed in Table 2.3.3.3-4 Worklist Attributes added to the standard DICOM image header for C-STORE.

The Ultrasound Image Storage SOP uses the Ultrasound Image IOD Modules as follows:

Ultrasound Image Storage Modules Used

Module	Usage	Description
Patient	M	Used
General Study	M	Used
Patient Study	U	Used
General Series	M	Used
Frame of Reference	U	Not used
US Frame of Reference	C	Not used
General Equipment	M	Used

General Image	M	Used
Image Pixel	M	Used
Contrast/bolus	C	Not used
Cine	C	Used (in Multiframe SOP)
Multi-frame	C	Used (in Multiframe SOP)
US Region Calibration	U	Used, if configured.
US Image	M	Used
Overlay Plane	U	Not used.
VOILUT	U	Used, if configured
SOP Common	M	Used
Curve Identification	M	Not used.
Curve	M	Not used.
Audio	U	Not used.
Curve SOP Common	M	Not used.

Each module which is used by the Storing AE has a table below which indicates the elements supported.

Patient Module Elements

Name	Tag	Type	VR	Range	Description
Patient's Name	0010, 0010	2	PN	xx	Patient name with ^ delimiters, supporting LAST^FIRST^M only. As of 10.1.2, Last Name field may contain up to 64 characters. If Last is less, then first will be filled. If space remains, Middle is added. Tag will not exceed 64 characters total, including ^ delimiters.
Patient ID	0010, 0020	2	LO	xx	18 char max
Birth Date	0010, 0030	2	DA	xx	Used
Patient Sex	0010, 0040	2	CS	xx	M, F, O or empty
Referenced Patient Sequence		3			Not used
Patient's Birth Time		3			Not used
Other Patient ID		3			Not used, unless provided by MWL server
Other Patient Names		3			Not used, unless provided by MWL server
Ethnic Group		3			Not used, unless provided by MWL server
Patient Comments		3			Not used, unless provided by MWL server

General Study Module Elements

Name	Tag	Type	VR	Range	Description
Study Instance UID	0020, 000D	1	UI	xx	For non-Worklist, generated by system. If Worklist is used, data from MWL server will be passed through with image.
Study Date	0008, 0020	2	DA	yyyymmdd	Exam date
Study Time	0008, 0030	2	TM	hhmmss	Exam time
Referring Physician Name	0008, 0090	2	PN		Zero length, unless provided by MWL server
Study ID	0020, 0010	2	SH	xx	System Generated exam number
Accession Number	0008, 0050	2	SH	xx	Used, may be blank if none entered. If Worklist is used, data from MWL server will be passed through with image.
Study Description	0008, 1030	3	LO	xx	Zero length, unless provided by MWL server.
Name of Reading Physician(s)		3			Not used, unless provided by MWL server
Referenced Study Sequence		3			Not used

General Series Module Elements

Name	Tag	Type	VR	Range	Description
Modality	0008, 0060	1	CS	US	Always US for ultrasound
Series Instance UID	0020, 000E	1	UI	xx	Used, one series per exam
Series Number	0020, 0011	2	IS	xx	series number in exam
Laterality	0020, 0060	2C			Not used
Series Date	0008, 0021	3	DA	yyyymmdd	Zero length if unknown
Series Time	0008, 0031	3	TM	hhmmss	Zero length if unknown
Performing Physician's Name	0008, 1050	3			Not used
Protocol Name	0018, 1030	3	LO	xx	Zero length
Series Description	0008, 103E	3	LO	xx	Used. For non-Worklist, generated by system. If Worklist is used, data from MWL server will be passed through with image.
Operator's Name	0008, 1070	3			Not used, unless provided by MWL server, mapped from Scheduled Performing Physician's Name (0040,0006)
Referenced Study Component Sequence	0008, 1111	3			Not used
Body Part Examined	0018, 0015	3			Not used
Patient Position	0018, 5100	2C			Not used
Smallest Pixel Value in Series	0028, 0108	3			Not used
Largest Pixel Value in Series	0028, 0109	3			Not used

General Equipment Module Elements

Name	Tag	Type	VR	Range	Description
Manufacturer	0008, 0070	2	LO	ATL	Used
Institution Name	0008, 0080	3	LO		Used
Institution Address		3			Not used
Station Name		3			Not used
Institutional Department Name		3			Not used
Manufacturer's Model Name	0008, 1090	3	LO	HDI 5000	Used
Device Serial Number		3			Not used
Software Version	0018, 1020	3	LO	xx	Used
Spatial Resolution		3			Not used
Date of Last Calibration		3			Not used
Time of Last Calibration		3			Not used
Pixel Padding Value		3			Not used

General Image Module Elements

Name	Tag	Type	VR	Range	Description
Image Number	0020, 0013	2	IS	1-200	Image number in exam
Patient Orientation	0020, 0020	2C	CS		Zero length
Image Date	0008, 0023	2C	DA	yyyymmdd	Used
Image Time	0008, 0033	2C	TM	hhmmss	Used
Image Type	0008, 0008	2	CS		Used, see Image Attribute Descriptions below
Acquisition Number		3			Not used

Acquisition Date		3			Not used
Acquisition Time		3			Not used
Referenced Image Sequence		3			Not used
Derivation Description		3			Not used
Source Image Sequence		3			Not used
Images in Acquisition		3			Not used
Image Comments	0020,4000	3	LT	xx	User annotation text or modality description. Max 20 char

Image Pixel Module Elements

Name	Tag	Type	VR	Range	Description
Samples/ Pixel	0028, 0002	1	US	1, 3	For Gray For Color
Photometric Interpretation	0028, 0004	1	CS	MONOCHROME2, RGB	For Gray For Color
Rows	0028, 0010	1	US	476 (NTSC), 576 (PAL)	Used
Columns	0028, 0011	1	US	640 (NTSC), 768 (PAL)	Used
Bits Allocated	0028, 0100	1	US	8	Used
Bits Stored	0028, 0101	1	US	8	Used
High Bit	0028, 0102	1	US	7	Used
Pixel Representation	0028, 0103	1	US	0	Unsigned ints
Pixel Data	7FE0, 0010	1	OB		Used
Planar Configuration	0028, 0006	1C	US	0, 1	0=Pixel Interleave, 1=Planar Only used in RGB.
Aspect Ratio	0028, 0034	1C	IS	68/68 (NTSC); 82/82 (PAL)	Pixel aspect ratio
Smallest Image Pixel Value	0028, 0106	3			Not used
Largest Image Pixel Value	0028, 0107	3			Not used
Red Palette Color Lookup Table Descriptor	0028, 1101	1C			Not used
Green Palette Color Lookup Table Descriptor	0028, 1102	1C			Not used
Blue Palette Color Lookup Table Descriptor	0028, 1103	1C			Not used
Red Palette Color Lookup Table Data	0028, 1201	1C			Not used
Green Palette Color Lookup Table Data	0028, 1202	1C			Not used
Blue Palette Color Lookup Table Data	0028, 1203	1C			Not used

US Image Module Elements

Name	Tag	Type	VR	Range	Description
Photometric Interpretation	0028, 0004	1	CS	MONOCHROME2 RGB	for Gray for Color
Pixel Representation	0028, 0103	1	US	0	Unsigned ints
Frame Increment Pointer	0028, 0009	1C	AT		Sequencing by frame time vector, only used in multiframe images.
Lossy Image Compression	0028, 2110	1C	CS		Used
Image Type	0008, 0008	2	CS		Used, see Image Attribute Descriptions below
Number Stages	0008, 2124	2C	IS	0	Present, always zero

Number Views in Stage	0008, 212A	2C	IS	0	Present, always zero
Referenced Overlay Sequence		3			Not used
Referenced Curve Sequence		3			Not used
Stage Name	0008, 2120	3	SH		Zero length
Stage Number	0008, 2122	3	IS	0	Present, always zero
View Number	0008, 2128	3	IS	0	Present, always zero
Number of Event Timers	0008, 2129	3	IS	0	Present, always zero
Event Elapsed Times	0008, 2130	3	DS		Zero length
Event Timer Name		3			Not used
Transducer Position		3			Not used
Transducer Orientation		3			Not used
Anatomic Structure		3			Not used
Trigger Time	0018, 1060	3	DS	0000	Present, always zero
Nominal Interval		3			Not used
Beat Rejection Flag		3			Not used
Low R-R Value		3			Not used
High R-R Value		3			Not used
Heart Rate	0018, 1088	3	IS	0	Present, always zero
Output Power		3			Not used
Transducer Data		3			Not used
Transducer Type		3			Not used
Focus Depth		3			Not used
Preprocessing Function		3			Not used
Mechanical Index		3			Not used
Bone Thermal Index		3			Not used
Cranial Thermal Index		3			Not used
Soft Tissue Thermal Index		3			Not used
Soft Tissue-focus Thermal Index		3			Not used
Soft Tissue-surface Thermal Index		3			Not used
Depth of Scan Field		3			Not used
Image Transformation Matrix		3			Not used
Image Translation Vector		3			Not used
Ultrasound color data present	0028, 0014	3	US	0 1	for Gray for Color

Image Attribute Descriptions

Image Type: This multi-value attribute is ORIGINAL/PRIMARY/(blank)/nnnn. The third field is always blank. This denotes *original* source databased on *primary* examination. *nnnn* is a bit map designating the image modes.

Value 4 is constructed as a modality bit map to allow for a description of multi-modality displays. In using this 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

Notes: 1. All Values are hexadecimal encoded as a CS.
2. For example, Color Flow with CW spectral Doppler would have a value 4 = 0015. Note that no assumption should be made in Color Doppler or Color M-Mode regarding underlying B or M-Mode, respectively. The

ultrasound image may contain a 2D Image portion in addition to M-Mode. The fourth field is the sum of the codes for the corresponding image types in a multiple format image.

Cine Module Elements

Name	Tag	Type	VR	Attribute Description
Start Trim	0008, 2142	3		Not Used
Stop Trim	0008, 2143	3		Not Used
Recommended Display Frame Rate	0008, 2144	3		Not Used
Cine Rate	0018, 0040	3		Not Used
Effective Duration	0018, 0072	3		Not Used
Frame Time	0018, 1063	1C		Not Used
Frame Time Vector	0018, 1065	1C	DS	An array which contains the real time increments (in msec) between frames for a Multi-frame image. Required only if Frame Increment Pointer (0028,0009) points to Frame Time Vector.
Frame Delay	0018, 1066	3		Not Used
Actual Frame Duration	0018, 1242	3		Not Used
Preferred Playback Sequencing	0018, 1244	3		Not Used

Multi-Frame Module Elements

Name	Tag	Type	VR	Range	Description
Number of Frames	0028, 0008	1	IS	2 - n	Number of frames in the loop
Frame Increment Pointer	0028, 0009	1	AT	0018, 1065	Tag that specifies the frame increment

US Region Calibration Module - Used if configured.

Name	Tag	Type	VR	Range	Description
Sequence of Ultrasound Regions	0018,6011	1	SQ	Sequence identifier	One of these may occur
Region Spatial Format	0018,6012	1	US		Used
Region Data Type	0018,6014	1	US		Used
Region Flags	0018,6016	1	UL		Used
Region Location Min X0	0018,6018	1	UL		Used
Region Location Min Y0	0018,601A	1	UL		Used
Region Location Max X1	0018,601C	1	UL		Used
Region Location Max Y1	0018,601E	1	UL		Used
Reference Pixel X	0018,6020	3	SL		Used
Reference Pixel Y	0018,6022	3	SL		Used
Physical Units X Direction	0018,6024	1	US		Used
Physical Units Y Direction	0018,6026	1	US		Used
Ref. Pixel Physical Value X	0018,6028	3	FD		Used
Ref. Pixel Physical Value Y	0018,602A	3	FD		Used
Physical Delta X	0018,602C	1	FD		Used
Physical Delta Y	0018,602E	1	FD		Used

Transducer Frequency	0018,6030	3	UL		Used
Transducer Type	0018,6031	3	UL		Used
Pulse Repetition Frequency	0018,6032	3			Not used
Doppler Correction Angle	0018,6034	3			Not used
Steering Angle	0018,6036	3			Not used
Doppler Sample Volume X Position	0018,6038	3			Not used
Doppler Sample Volume Y Position	0018,603A	3			Not used
TM-Line Position X0	0018,603C	3			Not used
TM-Line Position Y0	0018,603E	3			Not used
TM-Line Position X1	0018,6040	3			Not used
TM-Line Position Y1	0018,6042	3			Not used

VOI LUT Element

Name	Tag	Type	VR	Range	Description
Window Center	0028, 1050	3	DS	128	Description of Center point of range
Window Width	0028, 1051	1C	DS	256	Range assigned to 8 bit images (Required if Window Center is sent.)

SOP Common Module Elements

Name	Tag	Type	VR	Range	Description
SOP Class UID Image Storage.	0008, 0016	1	UI	Same as in Command Set	Same as in Command Set
SOP Instance UID	0008, 0018	1	UI	Same as in Command Set	Same as in Command Set
Specific Character Set		1C			Not used
Instance Creation Date		3			Not used
Instance Creation Time		3			Not used
Instance Creator ID		3			Not used

2.2.5 Storing AE Behavior to SCP Status

Storing AE Behavior to Status Returned from SCP

Status Value	Meaning	Description	Storing AE Behaviour
0000	Success		Upon successfully storing data to an archive server, the Storing AE will continue operation without user notification.
A7xx	Refused	Out of resources	The association is terminated. The user is notified of the failure.
A9xx	Error	Data set does not match SOP class	Same as A7xx.
Cxxx	Error	Cannot understand	Same as A7xx.
B000	Warning	Coercion of data elements	Ignored.
B007	Warning	Data set does not match SOP class	Same as A7xx.
B006	Warning	Elements discarded	Ignored.

2.3 Modality Work List AE - Specification

The Modality Worklist SOP Class in the Basic Worklist Service Class identifies the Modality Worklist Information Model, and the DIMSE-C operations supported. The following Standard SOP Class is used here:

SOP Class Name	SOP Class UID	Conformance Level
Modality Worklist Information Model – FIND	1.2.840.100008.5.1.4.31	Standard
Verification SOP Class	1.2.840.10008.1.1	Standard

2.3.1 Association Establishment Policies

The Modality Worklist AE will initiate an association under several conditions. The user may manually initiate a Worklist Update which will use the settings of the Automatic Query to determine the search criteria, and then issue the C-FIND command to the Modality Worklist server. After the requested data is returned, the association is closed.

The system may also be set for an automatic query to occur at intervals set by the user in the configuration screens.

2.3.1.1 General

Maximum PDU size offered: 32,768 bytes

Minimum PDU size accepted: 1,024 bytes

2.3.1.2 Number of Associations

Number of simultaneous associations for the Printing AE:

1 for Modality Worklist - FIND

Note that the other Application Entities in this device may be simultaneously active and thus other associations may be open simultaneously with this.

2.3.1.3 Asynchronous Nature

The Modality Worklist AE will not use asynchronous operations.

2.3.1.4 Implementation Identifying Information

Implementation Class UID: "1.2.840.113663.1"

Implementation Version name: "Tiller_v101"

Notes: "113663" is registered by ATL with ANSI. Version name above will be used initially but is subject to change with versions.

2.3.2 Association Initiation by: Real-World Activity

The Modality Worklist AE will open an association to the selected Modality Worklist Server when the real-world activity occurs corresponding to the user invocation of Update List, New Patient Data Entry or Selecting the Modality Worklist Server.

The Automatic Update function will initiate an update when the system is powered up, and connected to the network. If the Worklist server is selected when the system is powered up, a C-ECHO is issued upon completion of power up.

2.3.2.1 Association Initiation by: Update List

To use Update List, the user must enter the Patient Data Entry screen, and press “New Patient”. The user invocation of Update List will cause an association to be initiated to the Worklist Server. This association will remain active as long as required to return the requested matches from the Worklist server, then close.

2.3.2.2 Association Initiation by: New Patient Data Entry Panel

Use the Patient Data Entry hardkey to open the Patient Data Entry screen. Then invoke “New Patient” which will cause an End Exam to ensure that all previous exam images are transmitted from the system. The Worklist AE will perform a C-FIND based on the parameters set in the configuration panel and return the matching procedures.

2.3.2.3 Association Initiation by: Select Modality Worklist Server

Upon exiting the configuration panel for selecting the Modality Worklist Server, the system will initiate a DICOM Verify and execute the C-FIND request.

2.3.3 Proposed Presentation Context to a Modality Worklist Server

TABLE 2.3.3-1 MODALITY WORKLIST AE PROPOSED PRESENTATION CONTEXTS TO A WORKLIST SERVER

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Modality Worklist Information Model – FIND	1.2.840.10008.5.1.4.3 1	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None
Verification SOP Class	1.2.840.10008.1.1	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None

2.3.3.1 SOP Specific Conformance to Verification SOP Class

The Modality Worklist AE provides standard conformance to the Verification SOP Class as an SCU. The remote SCP must support the Verification SOP Class on the same Association as the Worklist C-FIND Service.

2.3.3.2 System Query Configuration Options

TABLE 2.3.3.2-1 SYSTEM QUERY CONFIGURATION OPTIONS

Query Action	Location of Entry	Settings
Auto Query	Image Management / Network Configuration / Worklist Server / Define Query	On / Off
Query Interval	Image Management / Network Configuration / Worklist Server / Define Query	15 min. default (minimum = 15, maximum = 120 minutes in 15 min. increments)
When selecting “New Patient”	Patient Data Entry Screen	Query criteria set in Define Query
Upon User Request (Search)	Patient Data Entry Screen. After Worklist is present, and Patient Name,	Query criteria set in Patient Data Entry.

	ID, Accession #, or specific date.	
--	------------------------------------	--

2.3.3.2.1 System Query Functions

TABLE 2.3.3.2.1-1 DATA USED FOR DIFFERENT SYSTEM OR USER QUERIES.

Query Type	Data Used	Located in:
<ul style="list-style-type: none"> Auto Query New Patient Update List 	<ul style="list-style-type: none"> Uses current system date System AE Title Station Name Station Location 	<ul style="list-style-type: none"> Setups / Display Host Table Define Query Screen Define Query Screen
<ul style="list-style-type: none"> Search (User Request) 	<ul style="list-style-type: none"> Patient Name (auto-appends (*)) Patient ID (must be exact) Accession Number (must be exact) Date (must be exact) Requested Procedure ID 	<ul style="list-style-type: none"> All in Patient Data Entry screen

2.3.3.3 Attributes Used for Modality Worklist Information Model

TABLE 2.3.3.3-1 SYSTEM QUERY MATCHING KEYS

Attribute Name	Tag	Key Type	Comments
Modality	0008,0060	R	Always Ultrasound
Scheduled Station AE Title	0040,0001	R	As set in the Host Table for the selected system
Scheduled Procedure Step Start Date	0040,0002	R	Current system date
Scheduled Station Name	0040,0010	O	System Name – Determined with CIS Administrator
Scheduled Procedure Step Location	0040,0011	O	System Location – Determined with CIS Administrator

TABLE 2.3.3.3-2 PROCEDURE QUERY MATCHING KEYS

Attribute Name	Tag	Key Type	Comments
Patient's Name	0010,0010	R	Single Value Matching or Wild Card Matching
Patient ID	0010,0020	R	Single Value Matching
Scheduled Procedure Start Date	0040,0002	R	Current system date
Accession Number	0008,0050	O	
Requested Procedure ID	0040,1001	O	
Modality	0008,0060	R	Always Ultrasound

TABLE 2.3.3.3-3 RETURNED ATTRIBUTES

Note: All requested tags are sent blank, and blank return values are accepted. The following tags, if returned, will be added to the C-Store Image Header. This feature is configurable on the system.

Attribute Name	Tag	Key Type	Comments
Accession Number	0008,0050	2	
Modality	0008,0060	1	Always Ultrasound
Referring Physician Name	0008,0090	2	
Admitting Diagnosis Description	0008,1080	3	
Patient's Name	0010,0010	1	
Patient ID	0010,0020	1	
Patient's Birth Date	0010,0030	2	
Patient's Sex	0010,0040	2	
Other Patient Ids	0010,1000	3	
Patient's Size	0010,1020	3	

Patient's Weight	0010,1030	3	
Ethnic Group	0010,2160	3	
Additional Patient History	0010,21B0	3	
Pregnancy Status	0010,21C0	3	
Last Menstrual Date	0010,21D0	3	
Patient Comments	0010,4000	3	
Study Instance UID	0020,000D	1	
Requested Procedure Description	0032,1060	1C	
Scheduled Station AE Title	0040,0001	1	
Scheduled Procedure Step Start Date	0040,0002	1	
Scheduled Procedure Step Start Time	0040,0003	1	
Scheduled Performing Physician's Name	0040,0006	2	
Scheduled Procedure Step Description	0040,0007	1C	
Scheduled Procedure Step ID	0040,0009	1	
Scheduled Station Name	0040,0010	2	
Scheduled Procedure Step Location	0040,0011	2	
Scheduled Procedure Step Sequence	0040,0100	1	
Requested Procedure ID	0040,1001	1	
Names Of Intended Recipients Of Results	0040,1010	3	

TABLE 2.3.3.3-4 WORKLIST ATTRIBUTES ADDED TO THE STANDARD DICOM IMAGE HEADER FOR C-STORE

Attribute Name	Tag	Comments
Study Description	0008,0030	Mapped from Scheduled Procedure Step Description (0040,0007)
Accession Number	0008,0050	
Referring Physician Name	0008,0090	
Series Description	0008,103E	Mapped from Scheduled Procedure Step Description (0040,0007)
Physician(s) Of Record	0008,1048	Mapped from Names Of Intended Recipients Of Results (0040,1010)
Operator's Name	0008,1070	If returned from Modality Worklist query, the Operator's Name field is mapped from Scheduled Performing Physician Name (0040,0006). Otherwise it is derived from the "SONOGRAPHER" field in the edit panel.
Admitting Diagnosis Description	0008,1080	
Patient's Name	0010,0010	
Patient ID	0010,0020	
Patient's Birth Date	0010,0030	
Patient's Sex	0010,0040	
Other Patient Ids	0010,1000	
Patient's Size	0010,1020	Patient's height or length in meters
Patient's Weight	0010,1030	Weight of the patient in kilograms
Ethnic Group	0010,2160	
Additional Patient History	0010,21B0	Data may be added in the edit field.
Pregnancy Status	0010,21C0	
Last Menstrual Date	0010,21D0	
Patient Comments	0010,4000	
Study Instance UID	0020,000D	
Scheduled Procedure Step	0040,0007	

Description		
Scheduled Procedure Step ID	0040,0009	
Requested Procedure ID	0040,1001	

2.3.4 Modality Worklist AE Behavior to SCP Status (C-FIND Response)

TABLE 2.3.4-1 MODALITY WORKLIST AE BEHAVIOR TO STATUS RETURNED FROM SCP

Status Value	Meaning	Related Fields	Description	Modality Worklist AE Behavior
0000	Success	None	Matching is Complete. No final Identifier is supplied.	Upon successfully connecting to a Modality Worklist server, and retrieving the requested data, the Modality Worklist AE will continue operation without user notification.
A700	Refused	(0000,0902)	Out of resources	The association is terminated. The user is notified of the failure.
A900	Failed	(0000,0901) (0000,0902)	Identifier does not match SOP class	Same as A7xx.
Cxxx	Failed	(0000,0901) (0000,0902)	Unable to Process	Same as A7xx.
FE00	Cancel	None	Matching is Terminated due to Cancel request	Terminated due to a Cancel Request.
FF00	Pending	Identifier	Matches are continuing.	Current Match is supplied and any Optional Keys were supported in the same manner as Required Keys.
FF01	Pending	Identifier	Matches are continuing.	Warning that one or more Optional Keys were not supported for existence for this Identifier.

3. Communication Profiles

3.1 TCP/IP Stack Supported

The TCP/IP protocol is used.

3.2 Physical Media Supported

Standard IEEE 802 (Ethernet) 10BaseT (twisted pair), 10Base2 (thin coax) and 10BaseFL (Fiber Optic Link) are supported using appropriate AUI port transceiver adapter unit.

Destination Ethernet address shall be acquired using the Address Resolution Protocol (ARP).

Internet Protocol (IP) address shall be acquired manually and pre-loaded into the device.

4. Extensions/Specializations/Privatizations

4.1 Standard Extended/Specialized/Private SOPs

None

4.2 Private Transfer Syntaxes

None

5. Configuration

This device obtains configuration information at the time of installation to provide the following.

- mapping from Application Entity Title to Presentation Address
- device configuration information

5.1 AE Title/Presentation Address Mapping

The translation from AE Title to Presentation Address is to be performed using a look up table loaded at installation or some other time.

5.2 Configurable Parameters

A lookup table contains the following configuration parameters.

- Application Entity Title
- IP Address
- Remote SCP Port number
- Station Name (*)
- Station Location (*)

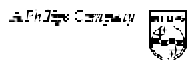
Selectable by System Option or Device File setting:

- US Regions Scaling Sequence
- Use of VOI LUT (Window Level = 256, and Window Center = 128)
- RGB as Planar or Pixel Interleave (Color-by-plane or Color-by-pixel)
- Network Read / Write Timeouts
- Storage Transfer Syntax, Implicit or Explicit VR Little Endian

(*) In Modality Worklist configuration screens.

6. Support of Extended Character Sets

Extended character sets are not supported.



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