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ExamWorks Version 1.4

DICOM Conformance Statement

009-81942-00

Revision History

Revision 1	Initial Release

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Table of Contents

0. Introduction

ExamWorks is a component of the MergeWorks™ family of DICOM network image management products. The ExamWorks allows DICOM imaging devices to connect to a DICOM network with Modality Worklist, Modality Perform Procedure Step, and Storage Commitment corrections. It provides efficient and transparent network connectivity, allowing imaging devices to operate in an integrated healthcare environment.

1. Implementation Model

1.1 Application Data Flow

ExamWorks acquires medical images for the purpose of print and/or image storage and defines five DICOM Application Entities (AE); the ExamWorks Basic Print AE, Modality Worklist Query AE, Image Send AE, Modality Perform Procedure Step AE, and Storage Commitment AE.

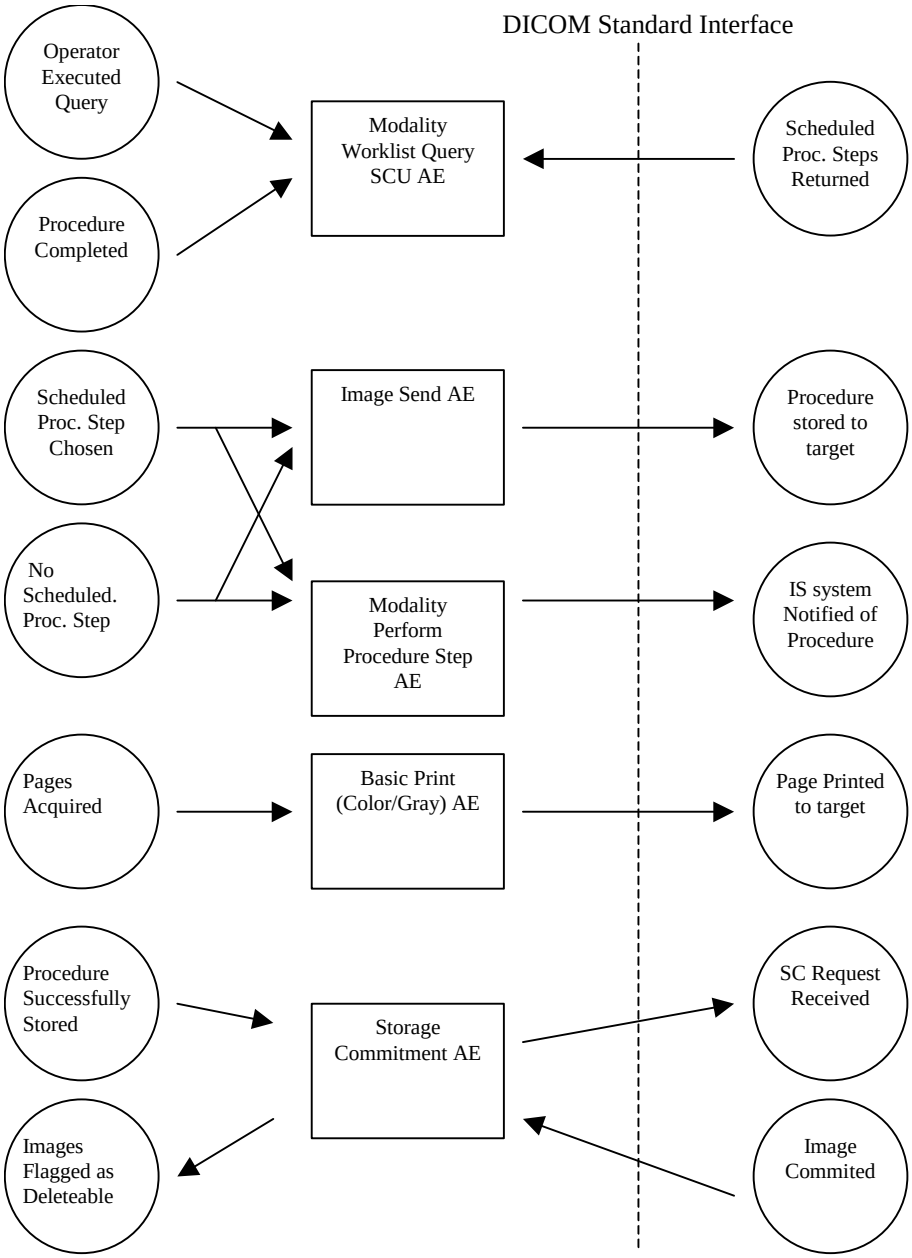

Figure 1: Implementation Model

The ExamWorks Application Entities define applications that handle DICOM protocol communication to accomplish DICOM Print Management, Secondary Capture Image Store capabilities, Modality Worklist Queries, Modality Performed Procedure Step, and Storage Commitment. The ExamWorks product is based on commercial print interfaces such as Imation 952, Imation 831, and SPCI. ExamWorks also has the capability to obtain information via the user interface. Therefore, the real-world activities that drive the ExamWorks' AEs are based on the above print interfaces, independent of whether DICOM print or image storage is being performed. The box will exhibit two different sets of real-world activities based on configuration. These activities are listed as follows:

1.1.1 ExamWorks with Retrospective Modality Worklist

Images are acquired on a page-by-page basis. These images are collected and collated for storage purposes based on time, user control, and image information. Films that need to be printed are printed at this time. When procedure collation has finished, the ExamWorks will perform a modality worklist query and attempt to reconcile the procedure with the appropriate modality worklist information. If this is not possible, then the user will need to review the information by hand in the user interface. If the user is unable to find the correct entry in the worklist, they may modify the data used in the query and re-query the worklist server, or select a new query to execute.

After the ExamWorks automatically selects a worklist entry, the user selects a worklist entry, or the user chooses to forgo using any worklist information, the ExamWorks will forward the page to the appropriate Storage operation, and send out the Modality Performed Procedure Step information.

If the target of the Storage operations is configured for Storage Commitment, the ExamWorks will wait for the target to return a confirmation before flagging the procedure as deletable.

1.1.2 ExamWorks with Prospective Modality Worklist

The user will execute a modality worklist query and select a response (or many) to apply to the forthcoming acquisitions. Upon confirmation, the system is ready for image acquisition. If the user choses not to pre-select a modality worklist entry, then follow the activities list in section **1.1.1 ExamWorks with Retrospective Modality Worklist**.

Images are acquired on a page-by-page basis. These images are collected and collated for storage purposes based on time and image information. Films that need to be printed are printed at this time. When procedure collation has finished, the ExamWorks will apply the pre-selected modality worklist entry. If the data read from the acquired images (through host information or ATR) differs from the preselected worklist entry, then the user will be prompted to confirm their pre-selection. If they cancel the preselection, then follow the activities list in section **1.1.1 ExamWorks with Retrospective Modality Worklist**.

Following the worklist confirmation, the ExamWorks will forward the procedure to the appropriate Storage operation, and send out the Modality Performed Procedure Step information.

If the target of the Storage operations is configured for Storage Commitment, the ExamWorks will wait for the target to return a confirmation before flagging the procedure as deletable.

In the case where the ExamWorks Basic Print AE is used, the film will be printed as formatted. Formatting is defined during from the image acquisition process. This definition may come from the user manually acquiring images, or through the host control information. When there are multiple Print devices, the print format will be as close to the desired format as possible for each DICOM print device.

In the case where the ExamWorks Image Send AE is used, the film format is ignored.

Some information required by DICOM, as part of a Secondary Capture Image (e.g. patient demographic information) is not obtainable through host control. ExamWorks can be configured for a particular input device to perform Automatic Text Recognition (ATR) that allows required fields that are annotated on the image to be extracted from the Pixel Data and communicated as part of the DICOM Storage Image. ATR places some restrictions on ExamWorks' DICOM Storage conformance that is detailed later in this document. ATR is also used to provide useful information to narrow down a query to the modality worklist server so that the user does not need to interact with the ExamWorks and reconcile every procedure to a worklist entry.

If a DICOM association is not already open with the remote device, one is established and either a Print or Storage operation performed. In either case, all component images are transferred over the association. In the case of Store the association can be closed and reopened for each procedure, while in the case of Print the association will close and reopen for each film.

1.2 Functional Definitions

The ExamWorks Basic Print AE supports the following functions:

- Formats the film sheet and image(s) via host control or keypad
- Obtains the "preformatted image" via digital or video mechanisms
- Initiates a DICOM association to transmit image(s) and associated print format information.

The ExamWorks Image Storage AE supports the following functions:

- Obtains the "preformatted image" via digital or video mechanisms plus other header information via ATR
- Initiates a DICOM association to transmit the image(s). The print format information is not sent.

The ExamWorks Modality Worklist Query AE supports the following functions:

- Initiates a DICOM association with a modality worklist SCP and issues modality worklist queries
- Enhances outgoing secondary capture and print objects with improved patient demographics and scheduling information

The ExamWorks Modality Perform Procedure Step AE supports the following functions:

- Initiates a DICOM association and send out DICOM MPPS N-CREATE & N-SET messages

The ExamWorks Storage Commitment AE supports the following functions:

- Initiates a DICOM association and commit every image from a procedure
- Listens for incoming DICOM associations and receive reports on the commitment status

1.3 Sequencing of Real-World Activities

1.3.1 Sequencing of ExamWorks with Retrospective Modality Worklist

Pages are acquired and collated into a procedure. After a procedure is finished, a worklist query will be generated by the Worklist AE. After a worklist entry has been chosen, the page will be sent to the MPPS AE and the print or storage AE as defined by the currently selected targets. If the targets support Storage Commitment, then the Storage Commitment AE will transmit a commit request and wait for a response.

1.3.2 Sequencing of ExamWorks with Prospective Modality Worklist

User generates a modality worklist query with the Worklist AE and selects an entry. User acquires a series of pages that are collated into a procedure. The finished procedure is sent to the MPPS AE and the print or storage AE as defined by the currently selected targets. If the targets support Storage Commitment, then the Storage Commitment AE will transmit a commit request and wait for a response.

2. Application Entity (AE) Specifications

2.1 ExamWorks Basic Print AE (Grayscale and Color)

This Application Entity provides Standard Conformance to the following DICOM V3.0 SOP Classes as an **SCU**:

SOP Class Name	SOP Class UID
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18

These DICOM Print related SOP Classes are implemented as a Standard DICOM SOP Classes (i.e. no private attributes are defined).

2.1.1 Association Establishment Policies

2.1.1.1 General

The DICOM Application Context Name (ACN), which is always proposed, is:

Application Context Name	1.2.840.10008.3.1.1.1

The Maximum Length PDU negotiation is included in all association establishment requests.

The maximum length PDU for an association initiated is:

Maximum Length PDU	28 Kbytes

The SOP class Extended Negotiation is not supported.

The maximum number of Presentation Contexts Items that will be proposed is 2.

The user info items sent by this product are:

- Maximum PDU Length
- Implementation Class UID

2.1.1.2 Number of Associations

The ExamWorks Basic Print AE has the ability to support one to twenty simultaneous associations, though this count is shared with the Storage AE.

2.1.1.3 Asynchronous Nature

Asynchronous mode is not supported. All operations will be performed synchronously.

2.1.1.4 Implementation Identifying Information

The Implementation Class UID for the ExamWorks implementation is:

Implementation Class UID	2.16.840.1.113669.2.1.1

2.1.2 Association Initiation by Real World Activity

On boot up, ExamWorks will attempt to open an Association with any of the configured DICOM print targets. The initial N-GET association closes immediately. If an association is not open, an attempt will be made to reopen the association when a print operation is requested.

2.1.2.1 Real World Activity PRINT A FILM

2.1.2.1.1 Associated Real World Activity

The ExamWorks Basic Print AE has the capability to print images via the DICOM Basic Print services using the Presentation Contexts defined in the Table shown in section 2.1.2.1.2, to all of the selected destination device(s).

The ExamWorks Basic Print AE will create a Film Session containing a single Film Box. The Basic Print AE will subsequently fill in the contents of the image boxes and request the print at the Film Box level. The Film Session is deleted once the Print has completed. A new Film Session is created for each successive film.

ExamWorks will propose either Basic Grayscale or Color based on configuration values on a target by target basis. ExamWorks can not send both color and grayscale to a specific target. When necessary, conversion between grayscale and color is provided as follows:

Acquisition Type	Accepted Presentation Context(s)	DICOM Method of Printing
Grayscale	Grayscale	Grayscale
	Color	Color (appears as grayscale)
Color	Grayscale	Grayscale (converted to grayscale)
	Color	Color

2.1.2.1.2 Proposed Presentation contexts

Presentation Context Table - Proposed					
Abstract Syntax		Transfer Syntax		Role	Expanded Negotiation
Name	UID	Name List	UID List		
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	Implicit VR Little Endian Explicit VR Little Endian Explicit VR Big Endian	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2	SCU	None
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18	Implicit VR Little Endian Explicit VR Little Endian Explicit VR Big Endian	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2	SCU	None

2.1.2.1.2.1 SOP Specific Conformance Statement for the Basic Print management SOP Classes

The ExamWorks Basic Print AE supports either the Basic Grayscale or Basic Color Print Management SOP Classes. Films are printed according to the real world activity described earlier (i.e. based on the various print scenarios).

Upon receiving a normalized service (N-CREATE, N-SET, etc.) response containing a Failure Status, the ExamWorks will release the association. The printing of the current film sheet will be considered failed. The ExamWorks Basic Print AE has the ability to automatically recover from this situation and will attempt to print the film at a later time. This retry mechanism will continue until the transfer of all images is successful.

2.1.2.1.2.1.1 Supported Optional DIMSE Service Elements

The only supported optional DIMSE service elements used by the Basic Print AE is N-DELETE of a Basic Film Session SOP Instance and the N-GET of a Printer SOP Instance.

2.1.2.1.2.1.2 Supported SOP Class Attributes (including optional attributes)

Because ExamWorks accepts many input protocols (e.g. Imation 952, Imation 831, SPCI) it may provide varying combinations of the optional (user selectable) attributes dependent on the input protocol. A list of all required and optional attributes (of an SCU) that may appear with the various SOP Classes making up Basic Print is given below. If no default value is listed the field will not be sent unless the ExamWorks is configured to fill in that value:

Basic Film Session SOP Class - N-CREATE			
Attribute Name	**Usage**	**Range of Values Default in Boldface (if applicable)**	**Tag**
Number of Copies Always sent as 1 unless set otherwise	U	1-99. A value is always sent in this field.	(2000,0010)
Print Priority	U	LOW, HIGH	(2000,0020)
Medium Type	U	BLUE FILM, CLEAR FILM	(2000,0030)
Film Destination	U	MAGAZINE, PROCESSOR	(2000,0040)
Film Session Label	U	1-64 characters used to describe the film session.	(2000,0050)

Basic Film Box SOP Class - N-CREATE			
Attribute Name	**Usage**	**Range of Values Default in Boldface (if applicable)**	**Tag**
Image Display Format	M	STANDARD\1,1 STANDARD\1,2 STANDARD\2,2 STANDARD\2,3 STANDARD\3,3 STANDARD\3,4 STANDARD\3,5 STANDARD\4,5 STANDARD\4,6 STANDARD\5,6	(2010,0010)

Referenced Film Session Sequence	M		(2010,0500)
>Referenced SOP Class UID	M		(0008,1150)
>Referenced SOP Instance UID	M		(0008,1155)
Film Orientation	U	PORTRAIT, LANDCAPE	(2010,0040)
Film Size ID	U	8INX10IN, 10INX14IN, 14INX14IN, 14INX17IN, 10INX12IN, 11INX14IN, 24CMX24CM, 24CMX30CM	(2010,0050)
Magnification Type	U	REPLICATE, BILINEAR, CUBIC, NONE	(2010,0060)
Max Density	U		(2010,0130)
Configuration Information	U		(2010,0150)
Smoothing Type	U		(2010,0080)
Border Density	U	BLACK, CLEAR	(2010,0100)
Empty Image Density	U	BLACK, WHITE	(2010,0110)
Min Density	U		(2010,0120)
Trim	U	YES, NO	(2010,0140)

Basic Grayscale Image Box SOP Class - N-SET			
Attribute Name	**Usage**	**Range of Values Default in Boldface (if applicable)**	**Tag**
Image Position	M		(2020,0010)
Preformatted Grayscale Image Sequence	M		(2020,0110)
>Samples per Pixel	M	1	(0028,0002)
>Photometric Interpretation	M	MONOCHROME1, MONOCHROME2	(0028,0004)
>Rows	M	number of rows in the image	(0028,0010)
>Columns	M	number of columns in the image	(0028,0011)
>Pixel Aspect Ratio	M	two valued attribute that is ratio of integers (vertical value\horizontal value)	(0028,0034)
>Bits Allocated	M	8	(0028,0100)
>Bits Stored	M	8	(0028,0101)
>High Bit	M	7	(0028,0102)
>Pixel Representation	M	0000H = unsigned integer	(0028,0103)
>Pixel Data	M	The plane of pixel data (left to right, row by row, top to bottom).	(7FE0,0010)
Polarity	U	NORMAL, REVERSE	(2020,0020)
Requested Image Size	U	Horizontal width of printed image in mm. Overrides optimal filling of image box.	(2020,0030)

Basic Color Image Box SOP Class - N-SET			
Attribute Name	**Usage**	**Range of Values Default in Boldface (if applicable)**	**Tag**
Image Position	M		(2020,0010)
Preformatted Color Image Sequence	M		(2020,0110)
>Samples per Pixel	M	3	(0028,0002)
>Photometric Interpretation	M	RGB	(0028,0004)
>Planar Configuration	M	0000 for interlaced or 0001 for interleaved	

>Rows	M	number of rows in each plane of the image	(0028,0010)
>Columns	M	number of columns in each plane of the image	(0028,0011)
>Pixel Aspect Ratio	M	two valued attribute that is ratio of integers (row value\column value)	(0028,0034)
>Bits Allocated	M	8	(0028,0100)
>Bits Stored	M	8	(0028,0101)
>High Bit	M	7	(0028,0102)
>Pixel Representation	M	0000H = unsigned integer	(0028,0103)
>Pixel Data	M	Three concatenated pixel planes in interleaved (R plane, followed by G plane, followed by B plane).	(7FE0,0010)
Polarity	U	NORMAL, REVERSE	(2020,0020)
Requested Image Size	U	Horizontal width of printed image in mm. Overrides optimal filling of image box.	(2020,0030)

Printer SOP Class - N-GET			
Attribute Name	**Usage**	**Range of Values Default in Boldface (if applicable)**	**Tag**
Printer Status	U	NORMAL, WARNING, FAILURE	(2110,0010)
Printer Status Info	U	SUPPLY EMPTY, SUPPLY LOW, RECEIVER FULL, FILM JAM	(2110,0020)
Printer Name	U	String of up to 64 characters.	(2110,0030)
Manufacturer	U	String of up to 64 characters.	(0008,0070)
Manufacturer Model Name	U	String of up to 64 characters.	(0008,1090)
Device Serial Number	U	String of up to 64 characters.	(0018,1000)
Software Versions	U	Multi-valued string of up to 64 characters.	(0018,1020)
Date of Last Calibration	U	DICOM DA Value Representation.	(0018,1200)
Time of Last Calibration	U	DICOM TM Value Representation	(0018,1201)

2.1.3 Association Acceptance Policy

Basic Print AE does not accept DICOM associations.

2.2 ExamWorks Image Storage AE Specification

This Application Entity provides Standard Conformance to the following DICOM V3.0 SOP Classes as an SCU:

SOP Class Name	SOP Class UID
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7

2.2.1 Association Establishment Policies

2.2.1.1 General

The DICOM Application Context Name (ACN), which is always proposed, is:

Application Context Name	1.2.840.10008.3.1.1.1

The Maximum Length PDU negotiation is included in all association establishment requests.

The maximum length PDU for an association initiated is:

Maximum Length PDU	28 Kbytes

The SOP class Extended Negotiation is not supported.

The maximum number of Presentation Contexts Items that will be proposed is 1.

The user info items sent by this product are:

- Maximum PDU Length
- Implementation Class UID
- Implementation Version Name

2.2.1.2 Number of Associations

The ExamWorks Image Storage AE has the ability to support one to twenty simultaneous associations, though this count is shared with the Print AE.

2.2.1.3 Asynchronous Nature

Asynchronous mode is not supported. All operations will be performed synchronously.

2.2.1.4 Implementation Identifying Information

The Implementation Class UID for the ExamWorks implementation is:

Implementation Class UID	2.16.840.1.113669.2.1.1

2.2.2 Association Initiation by Real World Activity

The ExamWorks Image Storage AE will initiate the sending (DICOM Storage) of the individual images making up a procedure when the user chooses to send without reconciling the procedure with a modality worklist entry, or a modality worklist entry is chosen.

2.2.2.1 Real World Activity END PROCEDURE

2.2.2.1.1 Associated Real World Activity

The ExamWorks transmits images via the DICOM Secondary Capture Image Storage Service Class using the Presentation Contexts defined in the Table shown in section 2.2.2.1.2, to all of the selected destination device(s).

2.2.2.1.2 Proposed Presentation contexts

Presentation Context Table - Proposed					
Abstract Syntax		**Transfer Syntax**		**Role**	**Expanded**
Name	**UID**	**Name List**	**UID List**		**Negotiation**
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian Explicit VR Little Endian Explicit VR Big Endian JPEG Baseline JPEG Extended 2_4 JPEG Lossless (Hier 14)	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2 1.2.840.10008.1.2.4.50 1.2.840.10008.1.2.4.51 1.2.840.10008.1.2.4.70	SCU	None

2.2.2.1.2.1 SOP Specific Conformance Statement for the Secondary Capture SOP Class

Images are managed by the ExamWorks Image Storage AE based on acquisition time, data, or user intervention. All images will be sent over the same association as separate C-STORE requests.

Upon receiving a C-STORE response containing an Error or a Refused status the implementation will release the association. All of the images in the procedure associated with this image will be considered by the ExamWorks to have failed to transfer. The ExamWorks Image Storage AE has the ability to automatically recover from this situation and will attempt to send all the images on the film at a later time. This retry mechanism will continue until the transfer of all images is successful or 100 (configurable) attempts have been made, at which point the ExamWorks will consider the procedure to be unrecoverable.

The following tables define the Image Storage AE's usage of the Secondary Capture SOP Class. Many of the attributes in the following tables (marked with a *) are NOT available in the print data stream and can only be acquired in one of three manners:

1. Automatic Text Recognition (ATR)
2. Value entered at keypad
3. Configured default value
4. Data from the Modality Worklist

The order of precedence can be configured with ATR first (as above) or after the default. For example, if the ExamWorks is configured to attempt to acquire the attribute via ATR, it will be attempted. If a value is found, its usage will depend on the priority ATR has been assigned (first or after default) and the existence of this value from the keypad or a configured default. If ATR fails, the ExamWorks will fall back to a value entered at the keypad, if one is available. Otherwise, it will fall back to a configured default value. If no default value is configured, then the ExamWorks will default to the appropriate value as defined by the DICOM Data Element Type for that attribute. Please refer to the DICOM standard PS 3.5.7.4 for further information.

For fields to be extracted via ATR they must remain in a consistent font and consistent location on all images. If one of the attributes obtained via ATR and listed below as required is not obtainable, NO ERROR will occur and the image will still be transmitted via Secondary Capture Store as stated in the order of precedence above.

Note: A failure to acquire an attribute via ATR does not result in an error. So it is important that if the missing attribute is required downstream in the image management path, that the keypad entered value is correct, or that the configured default value clearly indicates that data is missing (e.g. N/A, XXXXX, NULL value). An ATR failure is not considered a hard failure; it is only a missed opportunity to supply additional information.

Once ATR has been performed, the ExamWorks system will attempt to match the data present to a Modality Worklist entry. If that is successful, then the data from that request will be used. See Section 2.3.2.1 for further description of Modality Worklist.

2.2.2.1.2.1.1 Patient Entity Module

2.2.2.1.2.1.1.1 Patient Module

Attribute Name	Data Element	Type	Notes
Patient's Name* +	0010, 0010	2	See Note[1]
Patient's ID* +	0010, 0020	2	See Note[1]
Patient's DOB*	0010, 0030	2	See Note[1]
Patient's Sex*	0010, 0040	2	See Note[1]

***** The ExamWorks may be configured to obtain these attributes via Automatic Text Recognition (ATR).
\+ The ExamWorks may be configured to obtain these attributes via the keypad.

Note[1] Modality Worklist and/or ATR can provide values for these fields. If ExamWorks is configured to acquire the attribute via ATR it will attempt to do so. The ATR value or the value typed in at the keypad may be used first depending on configuration. If no value was assigned at the keypad, a configured default value will be used. If no default value is configured, then the ExamWorks will default to the appropriate value as defined by the DICOM Data Element Type for that attribute. Please refer to the DICOM standard PS 3.5.7.4 for further information.

2.2.2.1.2.1.2 Study Entity Module

2.2.2.1.2.1.2.1 General Study

Attribute Name	Data Element	Type	Notes
Study Date*	0008, 0020	2	Generated or See Note[1]
Study Time*	0008, 0030	2	Generated or See Note[1]

Accession Number*	0008, 0050	2	See Note[1]
Ref Physicians' Name*	0008, 0090	2	Zero length
Study Instance UID	0020, 000D	1	See Note[1]
Study ID* +	0020, 0010	2	See Note[1]

2.2.2.1.2.1.3 Series Entity Module

2.2.2.1.2.1.3.1 General Series

Attribute Name	Data Element	Type	Notes
Modality	0008, 0060	1	OT or See Note[1]
Series Instance UID	0020, 000E	1	
Series Number	0020, 0011	2	Sequential number of the series within the study.
Patient Laterality	0020, 0060	2C	no value, zero length

2.2.2.1.2.1.4 Equipment Entity Module

2.2.2.1.2.1.4.1 General Equipment

The attributes in this module are supported through configuration of ExamWorks by service personnel at the time of installation. Since this module is defined as user optional for Secondary Capture, all elements are supported as type 3. Note: This information is related to the equipment that generated the original image, not ExamWorks.

Attribute Name	Data Element	Type	Notes
Manufacturer	0008, 0070	3	
Institution Name	0008, 0080	3	
Station Name	0008, 1010	3	
Inst. Department Name	0008, 1040	3	
Mfg Model Name	0008, 1090	3	
S/W Versions	0018, 1020	3	

2.2.2.1.2.1.4.2 SC Equipment

Attribute Name	Data Element	Type	Notes
Modality	0008, 0060	3	OT or See Note[1]
Conversion Type	0008, 0064	1	DI = Digital Interface DV = Digitized Video
SC Dev Mfg	0018, 1016	3	Merge eFilm
SC Dev Model Name	0018, 1018	3	ExamWorks
SC Dev S/W Version	0018, 1019	3	Version 1.4 IB XX (XX is the build number)

2.2.2.1.2.1.5 Image Entity Module

2.2.2.1.2.1.5.1 General Image

Attribute Name	Data Element	Type	Notes
Image Type	0008, 0008	3	DERIVED \ SECONDARY
Image Date	0008, 0023	2C	no value, zero length
Image Time	0008, 0033	2C	no value, zero length
Image Number	0020, 0013	2	Image Number reflects the Image Position.
Patient Orientation	0020, 0020	2C	No value, zero length.

2.2.2.1.2.1.5.2 SC Image

Attribute Name	Data Element	Type	Notes
Date of Secondary Capture	0018, 1012	3	Not Sent
Time of Secondary Capture	0018, 1014	3	Not Sent

2.2.2.1.2.1.5.3 Image Pixel

Attribute Name	Data Element	Type	Notes
Samples per Pixel	0028, 0002	1	1 for MONOCHROME or 3 for RGB
Planar Configuration	0028, 0006	1C	Only sent for RGB, 0, or 1 in planes mode
Photometric Interpretation	0028, 0004	1	MONOCHROME2 MONOCHROME1 RGB
Rows	0028, 0010	1	Depends on Image source
Columns	0028, 0011	1	Depends on Image source
Pixel Aspect Ratio	0028, 0034	1C	Depends on Image source
Bits Allocated	0028, 0100	1	8
Bits Stored	0028, 0101	1	8
High Bit	0028, 0102	1	7
Pixel Representation	0028, 0103	1	0
Pixel Data	7FE0, 0010	1	

2.2.2.1.2.1.5.4 SOP Common

Attribute Name	Data Element	Type	Notes
SOP Class UID	0008, 0016	1	1.2.840.10008.5.1.4.1.1.7
SOP Instance UID	0008, 0018	1	

2.2.3 Association Acceptance Policy

Image Storage AE does not accept DICOM associations.

2.3 ExamWorks Modality Worklist Query AE Specification (w/ATR)

This Application Entity provides Standard Conformance to the following DICOM V3.0 SOP Classes as an **SCU**:

SOP Class Name	SOP Class UID
Modality Worklist Information Model - FIND	1.2.840.10008.5.1.4.31

2.3.1 Association Establishment Policies

2.3.1.1 General

The DICOM Application Context Name (ACN), which is always proposed, is:

Application Context Name	1.2.840.10008.3.1.1.1

The Maximum Length PDU negotiation is included in all association establishment requests.

The maximum length PDU for an association initiated is:

Maximum Length PDU	28 Kbytes

The SOP class Extended Negotiation is not supported.

The maximum number of Presentation Contexts Items that will be proposed is 1.

The user info items sent by this product are:

- Maximum PDU Length
- Implementation Class UID
- Implementation Version Name

2.3.1.2 Number of Associations

The Modality Worklist Management AE has the ability to support two simultaneous associations.

2.3.1.3 Asynchronous Nature

Asynchronous mode is not supported. All operations will be performed synchronously.

2.3.1.4 Implementation Identifying Information

The Implementation Class UID for the ExamWorks implementation is:

Implementation Class UID	2.16.840.1.113669.2.1.1

2.3.2 Association Initiation by Real World Activity

The ExamWorks will initiate a Modality Worklist Information Query via the Modality Worklist Query AE as studies are passed through the ExamWorks system. The operator may also initiate a Modality Worklist Information Query.

2.3.2.1 Real-world activity: Modality Worklist Query

2.3.2.1.1 Associated real-world activity for Modality Worklist Query

The ExamWorks Modality Worklist Query AE initiates an association to query a remote Information or PACS System. Upon completion of the C-FIND, the association is released. There are no timers related to the management of the association.

The operator views this information and then selects the appropriate patient that is used for image acquisition. The certain attributes obtained via the query are placed inside the image headers generated by the ExamWorks Modality Worklist Query and also conveyed in the Modality Performed Procedure Step object.

Upon receiving a C-FIND response containing a Failure Status, the ExamWorks aborts the association.

2.3.2.1.2 Proposed presentation contexts for Modality Worklist

The presentation context proposed by the ExamWorks Modality Worklist Query AE for the modality worklist service is as follows:

Modality Worklist Presentation Context Table

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
Modality Worklist Information Model – FIND	1.2.840.10008.5.1.4.31	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

2.3.2.1.2.1 SOP specific conformance for Modality Worklist Management SOP Class

Following are the status codes that are processed by the ExamWorks Modality Worklist Query AE when received from a remote Modality Worklist SCP system:

Service Status	Status Codes	Further Meaning	Behavior upon receiving Status Codes

Refused	A700	Out of resources	Processing of the matches and the association is terminated. Successful (if any) matches that have been previously received are not used.
Failed	A900	Identifier does not match SOP Class	The association is terminated and the status is logged into the system error log.
	Cxxx	Unable to process	Processing of the matches and the association is terminated. Successful (if any) matches that have been previously received are not used.
Cancel	FE00	Matching terminated due to cancel	Processing of the matches and the association is terminated. Successful (if any) matches that have been previously received are not used. Note that this should not occur, as the ExamWorks Modality Worklist Query AE does not initiate C-FIND-CANCEL requests.
Success	0000	Matching is complete - No final identifier is supplied	The association is released and the matches received are stored.
Pending	FF00	Matches are continuing - Current Match is supplied and any Optional Keys were supported in the same manner as Required Keys.	Processing of the matches continues.
	FF01	Matches are continuing - Warning that one or more Option Keys were not supported for existence of this identifier.	Processing of the matches continues without any warnings or errors.

The following table illustrates the Matching and Return Key attributes used by the ExamWorks AE when performing a query to the remote Modality Worklist SCP. Attributes that are used for Matching Keys provide matching based upon the DICOM requirements. Attributes that are used for Return Keys set the value to zero length (i.e. universal matching). The ExamWorks can be configured to not send any of these attributes in a query if necessary. If ATR is able to read any information that can be applied to the attributes in the modality worklist query, this can be used as search criteria.

DICOM Description / Module	**Tag**	**SCP Matching Key Type**	**SCP Return Key Type**	**Description**
Scheduled Procedure Step				
Scheduled Procedure Step Sequence	0040,0100	R	1	Generated by ExamWorks
>Scheduled station AE title	0040,0001	R	1	This value may be based on the AE title assigned to the Modality Worklist Query AE
>Scheduled Procedure Step Start Date	0040,0002	R	1	This attribute may be set up to send a range based on an offset and current system time
>Scheduled Procedure Step Start Time	0040,0003	R	1	This attribute may be set up to send a range based on an offset and current system time
>Modality	0008,0060	R	1	Generated by ExamWorks

>Scheduled Procedure Step Description	0040,0005	O	1C	
>Scheduled Action Item Code Sequence	0040,0008	O	1C	
>Scheduled Procedure Step ID	0040,0009	O	1	
Requested Procedure				
Requested Procedure ID	0040,1001	O	1	
Requested Procedure Description	0032,1060	O	1C	
Requested Procedure Code Sequence	0032,1064	O	1C	
Study Instance UID	0020,000D	O	1	
Referenced Study Sequence	0008,1110	O	2	
Imaging Service Request				
Accession Number	0008,0050	O	2	This value may be changed by the operator
Referring Physician's Name	0008,0090	O	2	
Patient Identification				
Patient's Name	0010,0010	R	1	This value may be changed by the operator
Patient ID	0010,0020	R	1	This value may be changed by the operator
Patient Demographic				
Patients Birth Date	0010,0030	O	2	
Patient's Sex	0010,0040	O	2	
Patient's Weight	0010,1030	O	2	
Patient's Size	0010,1020	O	2	
Occupation	0010,2180	O	3	
Patient Medical				
Additional Patient's History	0010,21B0	O	3	
Visit Admission				
Admitting Diagnosis Description	0008,1080	O	3	

2.3.3 Association Acceptance Policy

ExamWorks does not accept DICOM associations.

2.4 ExamWorks Modality Perform Procedure Step AE Specification

This Application Entity provides Standard Conformance to the following DICOM V3.0 SOP Classes as an SCU:

SOP Class Name	SOP Class UID
Modality Performed Procedure Step SOP Class	1.2.840.10008.3.1.2.3.3

2.4.1 Association Establishment Policies

2.4.1.1 General

The DICOM Application Context Name (ACN), which is always proposed, is:

Application Context Name	1.2.840.10008.3.1.1.1

The Maximum Length PDU negotiation is included in all association establishment requests.

The maximum length PDU for an association initiated is:

Maximum Length PDU	28 Kbytes

The SOP class Extended Negotiation is not supported.

The maximum number of Presentation Contexts Items that will be proposed is 1.

The user info items sent by this product are:

- Maximum PDU Length
- Implementation Class UID
- Implementation Version Name

2.4.1.2 Number of Associations

The Modality Perform Procedure Step AE has the ability to support one association.

2.4.1.3 Asynchronous Nature

Asynchronous mode is not supported. All operations will be performed synchronously.

2.4.1.4 Implementation Identifying Information

The Implementation Class UID for the ExamWorks implementation is:

Implementation Class UID	2.16.840.1.113669.2.1.1

2.4.2 Association Initiation by Real World Activity

The ExamWorks will initiate a Modality Perform Procedure Step N-CREATE and N-SET via the Modality Perform Procedure Step AE as scheduled procedures steps are confirmed for this procedure.

2.4.2.1 Real-world activity: SCHEDULED PROCEDURE STEP(s) CHOSEN / NO SCHEDULED PROCEDURE STEP FOR THIS PERFORMED PROCEDURE

2.4.2.1.1 Associated real-world activity for Modality Perform Procedure Step

The ExamWorks Modality Perform Procedure Step AE initiates an association to the PPS server and sends an N-CREATE message with all appropriate information for the study. An N-SET message is then sent with end dates and times, with a status of COMPLETED or DISCONTINUED, and image instance information. Upon completion of the N-SET, the association is released.

2.4.2.1.2 Proposed presentation contexts for Modality Worklist

The presentation context proposed by the ExamWorks Modality Perform Procedure Step AE is as follows:

Performed Procedure Step Presentation Context Table

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**			**Extended**
Name	**UID**	**Name**	**UID**	**Role**	**Negotiation**
Modality Performed Procedure Step SOP Class	1.2.840.10008.3.1.2.3.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

2.4.2.1.2.1 SOP specific conformance for Modality Performed Procedure Step SOP Class

2.4.2.1.2.1.1 Modality Performed Procedure Step - N-CREATE

The following table defines the use of the N-CREATE DIMSE Service.

Message Field	Tag	Req. Type SCU/SCP	Description
Scheduled Procedure Step Information			
Scheduled Step Attribute Seq.	0040,0270	1/1	
>Study Instance UID	0020,000D	1/1	Obtained via Modality Worklist else initial image
>Referenced Study Sequence	0008,1110	2/2	Obtained via Modality Worklist or sent zero length
>Accession Number	0008,0050	2/2	Obtained via Modality Worklist or operator input or sent zero length
>Requested Procedure ID	0040,1001	2/2	Obtained via Modality Worklist or sent zero length
>Requested Procedure Description	0032,1060	2/2	Obtained via Modality Worklist or sent zero length
>Scheduled Procedure Step ID	0040,0009	2/2	Obtained via Modality Worklist or sent zero length

>Scheduled Procedure Step Description	0040,0007	2/2	Obtained via Modality Worklist or sent zero length
>Scheduled Action Item Code Sequence	0040,0008	2/2	Obtained via Modality Worklist or sent zero length
>>Code Value	0008,0100	1C/1	Sent if Sequence Item is present
>>Coding Scheme designator	0008,0102	1C/1	Sent if Sequence Item is present
>>Code Meaning	0008,0104	3/3	Sent if Sequence Item is present and available in the Modality Worklist
Patient's Name	0010,0010	2/2	Obtained via incoming data, Modality Worklist ,or operator input or sent zero length
Patient ID	0010,0020	2/2	Obtained via incoming data, Modality Worklist ,or operator input or sent zero length
Patient's Birth Date	0010,0032	2/2	Obtained via incoming data, Modality Worklist ,or operator input or sent zero length
Patient's Sex	0010,0040	2/2	Obtained via incoming data, Modality Worklist ,or operator input or sent zero length
Referenced Patient Sequence	0008,1120	2/2	Sent zero length
Performed Procedure Step Information			
Performed Procedure Step ID	0040,0253	1/1	Obtained via incoming data or Generated by ExamWorks
Performed Station AE Title	0040,0241	1/1	Generated by ExamWorks
Performed Procedure Step Start Date	0040,0244	1/1	Obtained via incoming data, study date, or Generated by ExamWorks
Performed Procedure Step Start Time	0040,0245	1/1	Obtained via incoming data, study time, Generated by ExamWorks
Performed Procedure Step Status	0040,0252	1/1	IN PROGRESS
Performed Procedure Step Description	0040,0254	2/2	Obtained via incoming data, study description, or Sent zero length
Performed Procedure Type Description	0040,0255	2/2	Sent zero length
Procedure Code Sequence	0008,1032	2/2	Sent zero length
Performed Procedure Step End Date	0040,0250	2/2	Sent zero length
Performed Procedure Step End Time	0040,0251	2/2	Sent zero length
Image Acquisition Results			
Modality	0008,0060	1/1	
Study ID	0020,0010	2/2	Generated by ExamWorks

Performed Action Item Code Sequence	0040,0260	2/2	Sent zero length
Performed Series Sequence	0040,0340	2/2	Sent zero length

2.4.2.1.2.1.2 Modality Performed Procedure Step - N-SET

The following table defines the use of the N-SET DIMSE Service.

Message Field	Tag	Req. Type SCU/SCP	Description
Scheduled Procedure Step Information			
Scheduled Step Attribute Seq.	0040,0270	Not allowed	No attributes in this sequence may be set
Patient's Name	0010,0010	Not allowed	
Patient ID	0010,0020	Not allowed	
Patient's Birth Date	0010,0032	Not allowed	
Patient's Sex	0010,0040	Not allowed	
Referenced Patient Sequence	0008,1120	Not allowed	No attributes in this sequence may be set
Performed Procedure Step Information			
Performed Procedure Step ID	0040,0253	Not allowed	
Performed Station AE Title	0040,0241	Not allowed	
Performed Station Name	0040,0242	Not allowed	
Performed Location	0040,0243	Not allowed	
Performed Procedure Step Start Date	0040,0244	Not allowed	
Performed Procedure Step Start Time	0040,0245	Not allowed	
Performed Procedure Step Status	0040,0252	3/1	COMPLETED or DISCONTINUED
Performed Procedure Step Description	0040,0254	3/2	
Performed Procedure Step End Date	0040,0250	2/2	Generated by ExamWorks
Performed Procedure Step End Time	0040,0251	2/2	Generated by ExamWorks
Image Acquisition Results			
Modality	0008,0060	Not allowed	
Study ID	0020,0010	Not allowed	
Performed Action Item Code Sequence	0040,0260	2/2	Set Zero Length

>Code Value	0008,0100	1C/1	
>Coding Scheme Designator	0008,0102	1C/1	
>Code Meaning	0008,0104	3/3	
Performed Series Sequence	0040,0340	2/2	
>Performing Physician's Name	0008,1050	2C/2	Set Zero Length
>Protocol Name	0018,1030	1C/1	User Selection
>Operator's Name	0008,1070	2C/2	User Selection
>Series Instance UID	0020,000E	1C/1	Generated by ExamWorks
>Series Description	0008,103E	2C/2	Set Zero Length
>Retrieve AE Title	0008,0054	2C/2	Set Zero Length
>Referenced Image Sequence	0008,1140	2C/2	
>>Referenced SOP Class UID	0008,1150	1C/1	Generated by ExamWorks
>>Referenced SOP Instance UID	0008,1155	1C/1	Generated by ExamWorks

2.4.3 Association Acceptance Policy

Modality Perform Procedure Step AE does not accept DICOM associations.

2.5 ExamWorks Storage Commitment AE Specification

This Application Entity provides Standard Conformance to the following DICOM V3.0 SOP Classes as a SCU:

SOP Class Name	SOP Class UID
Storage Commitment	1.2.840.10008.1.20.1

2.5.1 Association Establishment Policies

2.5.1.1 General

The DICOM Application Context Name (ACN), which is always proposed, is:

Application Context Name	1.2.840.10008.3.1.1.1

The Maximum Length PDU negotiation is included in all association establishment requests.

The maximum length PDU for an association initiated is:

Maximum Length PDU	28 Kbytes

The SOP class Extended Negotiation is not supported.

The maximum number of Presentation Contexts Items that will be proposed is 1.

The user info items sent by this product are:

- Maximum PDU Length
- Implementation UID

2.5.1.2 Number of Associations

The ExamWorks Storage Commitment AE has the ability to support multiple associations.

2.5.1.3 Asynchronous Nature

Asynchronous mode is not supported. All operations will be performed synchronously.

2.5.1.4 Implementation Identifying Information

The Implementation Class UID for the ExamWorks implementation is:

Implementation Class UID	2.16.840.1.113669.2.1.1

2.5.2 Association Initiation by Real World Activity

The ExamWorks Storage Commitment AE will initiate the storage commitment N-ACTION requests as soon as all images in a procedure have been stored to all targets without error.

2.5.2.1 Real-world activity: PROCEDURE SUCCESSFULLY STORED

2.5.2.1.1 Associated real-world activity for Storage Commitment

Upon successful transfer of images for a procedure, the ExamWorks Storage Commitment AE initiates an association for the request of Storage Commitment on a remote Archive or PACS System. Upon completion of the N-ACTION, the association is released. In order to relate the N-ACTION to future updates (i.e. incoming N-EVENT-REPORTs) the Transaction UID used is recorded. There are no timers related to the management of the association.

Upon receiving an incoming association with an N-ACTION response containing a Failure Status, the status will be logged to the system log file and the implementation will terminate the association.

For cases when the called Storage Commitment SCP is not functioning (i.e. momentarily off-line), the ExamWorks Storage Commitment implementation queues the N-ACTION request for future retransmission. This queue is "non-blocking" which enables ExamWorks to continue acquiring imaging procedures while the Storage Commitment SCP is off-line. A configurable timer is set to trigger the retransmission of the queued entries. Entries are not to be deleted from the queue unless done so by a successful response from the commitment target for the N-ACTION message.

The N-ACTION message is generated without operator interaction.

2.5.2.1.2 Proposed presentation contexts for Storage Commitment

The presentation context proposed by the ExamWorks Storage Commitment is as follows:

Storage Commitment Presentation Context Table

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
Storage Commitment	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

2.5.2.1.2.1 SOP specific conformance for Storage Commitment SOP Class

The ExamWorks Storage Commitment AE provides Standard conformance to the Storage Commitment SOP Class.

There are no SOP class specific status codes defined by DICOM for the N-ACTION or the N-EVENT-REPORT, therefore, only general statuses from PS3.7 are used.

2.5.3 Association Acceptance Policy

The ExamWorks Storage Commitment AE will accept all incoming associations as defined by the following real world activities.

2.5.3.1 Real World Activity IMAGES COMMITTED

The incoming N-EVENT-REPORT is the reply generated by the called storage commitment SCP to the above N-ACTION. Upon receiving an N-EVENT-REPORT message containing failed requests, the status will be logged to the system log file.

2.5.3.1.1 Associated Real World Activity

The ExamWorks receives N-EVENT-REPORT using the Presentation Contexts defined in the Table shown in section 2.4.3.1.2, to all of the selected destination device(s).

2.5.3.1.2 Acceptable Presentation Contexts

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
Storage Commitment	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

2.5.3.1.2.1 SOP Specific Conformance Statement for the Storage SOP Classes

This Application Entity provides Standard Conformance to the SOP Classes defined in the SOP Class table in section 2.4.

2.5.3.1.3 Presentation Context Acceptance Criterion

All of the above presentation context in section 2.4.3.1.2 are accepted.

2.5.3.1.4 Transfer Syntax Selection Policies

The Storage Commitment AE SCU accepts Implicit Little Endian.

3. Communication Profiles

3.1 Supported Communication Stacks

3.1.1 OSI Stack

Not applicable to this product.

3.1.2 TCP/IP Stack

DICOM Upper Layer (PS 3.8) is supported using TCP/IP. The TCP/IP stack is inherited from the operating system.

3.1.2.1 API

Not applicable to this product.

3.1.2.2 Physical Media Support

Ethernet v2.0, IEEE 802.3.

3.1.3 Point-to-Point Stack

Not applicable to this product.

4. Extensions/Specialization's/Privatization's

ExamWorks provides standard conformance to all implemented SOP classes.

5. Configuration

5.1 AE Title/Presentation Address Mapping

The following fields are configurable for the ExamWorks AEs (local):

- Local AE Title
- Local IP Address

The following fields are configurable for every remote DICOM AE:

- Remote AE Titles
- Listening TCP/IP Port
- Remote IP Address

5.2 Other Configurable Parameters

Each association negotiation supports an " Association Timer ", called ARTIM. This timer starts when the association request is sent and stops when the association is established. This timer is configurable by the Merge Service Engineer to facilitate WAN connections. The default value is set to 30 seconds.

Each association also supports a WRITE_TIMEOUT for individual writes throughout the life of the association. This timer starts at the beginning of the network transmission of a PDU. If the timeout is reached, the ExamWorks AE ceases the transmission of the PDU and aborts the association. This timer is also adjustable by the Merge Service engineer to facilitate WAN connections. The default value is 15 seconds.

6. Support of Extended Character Sets

The ISO Latin 1 character set is supported for the Image Send AE, as well as the Modality Worklist Query and Modality Performed Procedure Step AEs.