esaote

Artoscan-C
C-scan
E-scan XQ
E-scan Opera
G-scan
S-scan
Vet-MR
Vet-MR Grande

Dedicated MRI Systems

DICOM Conformance Statement

Revision 2.3

Date 28 MAY 2007

1 CONFORMANCE STATEMENT OVERVIEW

The Artoscan-C, C-scan, E-scan XQ, E-scan Opera, G-scan, Vet-MR and Vet-MR Grande are dedicated MRI scanners made by ESAOTE S.p.A.; their software is based upon the Windows® 2000 Operating System. This DICOM® Conformance Statement (DCS) specifies the conformance to the DICOM standard[1] for these ESAOTE Dedicated MRI systems ("ESAOTE MRI systems")[2].

The ESAOTE MRI systems implement the necessary DICOM services to download work lists from an information system, save acquired MR images to a network storage device, CD-R or DVD, print to a networked hardcopy device and receive MR images from the network.

Parts of this document are taken from the templates present in the DICOM standard document PS 3.2-2004, © Copyright 2004 by the National Electrical Manufacturers Association.

Table 1 provides an overview of the network services supported.

Table 1
NETWORK SERVICES

SOP Classes	User of Service (SCU)	Provider of Service (SCP)
Transfer		
MR Image Storage	Yes	Yes
Workflow Management		
Modality Worklist	Yes	No
Print Management		
Basic Grayscale Print Management	Yes	No

Table 2 provides an overview of the Media Storage Application Profiles supported.

Table 2
MEDIA SERVICES

Media Storage Application Profile	Write Files (FSC)	Read Files (FSR)
Compact Disk – Recordable		
General Purpose CD-R (MR Images only) (STD-GEN-CD)	Yes	Yes
CT/MR Studies on CD-R (STD-CTMR-CD)	Yes	No
DVD		
CT/MR Studies on DVD Media (STD-CTMR-DVD)	Yes	No
General Purpose DVD Interchange with JPEG (STD-GEN-DVD-JPEG)	Yes	No

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[1] DICOM is the registered trademark of the National Electrical Manufacturers Association for its standards publications relating to digital communications of medical information.

[2] Vet-MR Grande and E-scan Opera are supported since software release 9.2A.

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3 INTRODUCTION

3.1   REVISION HISTORY

Table 3
REVISION HISTORY

Document Version	Date of Issue	Author	Description	SW Releases
2.0	December 17, 2004	Luigi Pampana-Biancheri, Marco Spaggiari	From the PS3.2-2004 templates.	9.0A / 9.0B
2.1	March 13, 2006	Marco Spaggiari	• Revision of the table 4. • Revision of the paragraph 5.1.3. • Revision of the tables 62, 64 and 69. • Revision of the paragraph 8.7. • Revision of the tables 74, 75 and 76. • Other minor changes.	9.1A / 9.2A / 9.3A / 9.3B
2.2	December 06, 2006	Marco Spaggiari	• Revision of the table 2. • Revision of the paragraph 3.3. • Revision of the paragraph 3.4. • Revision of the table 4. • Revision of the tables 10, 16, 21, 28 and 36. • Revision of the section 5. • Revision of the table 62. • Revision of the table 65. • Revision of the paragraph 8.1.2. • Revision of the table 74. • Revision of the table 76. • Other minor changes.	9.4A
2.3	May 28, 2007	Marco Spaggiari	• Revision of the table 4. • Revision of the table 64. • Revision of the table 69. • Revision of the table 74. • Revision of the table 75. • Other minor changes.	9.5A / 9.5B / 9.6A

This document applies to all the software releases of the ESAOTE MRI systems, starting with the 9.0A and up to the current one: always check for the latest revision of it. Foot page notes will appear indicating the differences among the various software releases and systems, if any.

In case of differences between the behavior of the same software release for the different systems, the following identifiers will be used: C-*m.np* for the Artoscan-C/C-scan software releases, E-*m.np* for the E-scan XQ software releases, O-*m.np* for the E-scan Opera software releases, G-*m.np* for the G-scan software

releases, S-*m.np* for the S-scan software releases, V-*m.np* for the Vet-MR software releases and VG-*m.np* for the Vet-MR Grande software releases (for example, V-9.0A means Vet-MR software release 9.0A).

In the Table 3 we describe the history of the revisions of the present document, together with the latest software releases covered by them.

For any other information, or for the latest version of this document, please contact us:

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Please note that this document can be changed at any time without notice. ESAOTE S.p.A. provides this documentation without warranty of any kind.

3.2   AUDIENCE

This document is intended for hospital staff, health system integrators, software designers or implementers. It is assumed that the reader has a working understanding of DICOM.

3.3   REMARKS

DICOM, by itself, does not guarantee interoperability. However, the Conformance Statement facilitates a first-level validation for interoperability between different applications supporting the same DICOM functionality.

This Conformance Statement is not intended to replace validation with other DICOM equipment to ensure proper exchange of information.

The scope of this Conformance Statement is to facilitate communication with the ESAOTE MRI systems and other vendors' Medical equipments. The Conformance Statement should be read and understood in conjunction with the DICOM Standard [DICOM]. However, by itself, it is not guaranteed to ensure the desired interoperability and a successful interconnectivity.

The user should be aware of the following important issues:

— The comparison of different conformance statements is the first step towards assessing interconnectivity between ESAOTE MRI systems and other equipments.

— Test procedures should be defined to validate the desired level of connectivity.

— The DICOM standard will evolve to meet the users' future requirements. ESAOTE is actively involved in developing the standard further and therefore reserves the right to make changes to its products or to discontinue their delivery.

Before the 9.4A software release the DICOM functionalities given by the ESAOTE MRI systems were implemented by means of the EDMG Library, a DICOM software library which has been developed by the ESAOTE DICOM Management Group (EDMG), in order to offer to all the ESAOTE modalities and applications a common DICOM platform. The EDMG library relies in its turn on the MergeCOM 3™ Advanced DICOM Toolkit ("DICOM by Merge").

Starting from the 9.4A software release the EDMG Library has been substituted by its evolution, now called DCMLab, still developed by the ESAOTE DICOM Management Group (EDMG), but based on the EbitAET EMGDicom Toolkit by EbitAET S.p.A., a company of the same group of ESAOTE S.p.A.

The DICOM standard does not contain any specific veterinary attribute or defined term, so that the DICOM attributes of the veterinary images produced by the Vet-MR will have a meaning that could not exactly match their DICOM definition: the exact meaning could depend on the User's policies. See section 8.7 for further detalis.

3.4   DEFINITIONS, TERMS AND ABBREVIATIONS

Definitions, terms and abbreviations used in this document are defined within the different parts of the DICOM standard.

Abbreviations and terms are as follows:

AE	DICOM Application Entity
AET	Application Entity Title
ASCE	Association Control Service Element
DIT	Directory Information Tree (LDAP)
DN	Distinguished Name (LDAP)
CD-R	Compact Disk Recordable
DVD	A trademark of the DVD Forum that is not an abbreviation
CSE	Customer Service Engineer
FSC	File-Set Creator
FSU	File-Set Updater
FSR	File-Set Reader
GSDF	Grayscale Standard Display Function
GSPS	Grayscale Softcopy Presentation State
IOD	(DICOM) Information Object Definition
ISO	International Standard Organization
LDAP	Lightweight Directory Access Protocol
LDIF	LDAP Data Interchange Format
MPPS	Modality Performed Procedure Step
MSPS	Modality Scheduled Procedure Step
R	Required Key Attribute
O	Optional Key Attribute
PDU	DICOM Protocol Data Unit
RDN	Relative Distinguished Name (LDAP)
SCU	DICOM Service Class User (DICOM client)
SCP	DICOM Service Class Provider (DICOM server)
SOP	DICOM Service-Object Pair
U	Unique Key Attribute

Some of the tables have a "**Presence of …**" column in which the following abbreviations are used, unless specified:

VNAP   Not Always Present (attribute sent zero length if no value is present)

ANAP   Not Always Present

ALWAYS   Always Present

EMPTY   Attribute is sent without a value

The abbreviations used in the "**Source**" column:

MWL   the attribute value source is the Modality Worklist

USER   the attribute value comes from the User input

AUTO   the attribute value is generated automatically

CONFIG   the attribute value is a configurable parameter

PROFILE   the attribute value is a parameter found in the profile chosen for the selected printer

3.5   REFERENCES

[DICOM] Digital Imaging and Communications in Medicine (DICOM), NEMA PS 3.1-3.18, 2004 and following editions.

3.6   IMPLEMENTATION IDENTIFYING INFORMATION

The Implementation Class UID and Implementation Version Name are the same for all the Application Entities, and can change according to the software release. For every software release of the various ESAOTE MRI systems covered by this DICOM Conformance Statement, describes the implementation identifying information, together with the DICOM library and toolkit releases used.

Table 4
IMPLEMENTATION IDENTIFYING INFORMATION

Software releases	EDMG SW Release	MergeCOM-3 SW Release	Implementation Class UID	Implementation Version Name
9.0A	5.4.1	3.2.0	1.3.76.2.1.1.3	EOB_MRI_WIN_90A
9.0B	5.4.1	3.2.0	1.3.76.2.1.1.3	EOB_MRI_WIN_90B
9.1A	5.5.2	3.2.0	1.3.76.2.1.1.3	EOB_MRI_WIN_91A
9.2A	6.3	3.2.0	1.3.76.2.1.1.3	EOB_MRI_WIN_92A
9.3A	6.3	3.2.0	1.3.76.2.1.1.3	EOB_MRI_WIN_93A
9.3B	6.3	3.2.0	1.3.76.2.1.1.3	EOB_MRI_WIN_93B

Software releases	DCMLab SW Release	EMGDicom SW Release	Implementation Class UID	Implementation Version Name
9.4A	2.1	4.2	1.3.76.2.1.1.4	EOB_MRI_AET_94A
9.5A	2.2.2	4.2	1.3.76.2.1.1.4	EOB_MRI_AET_95A
9.5B	2.2.5	4.2	1.3.76.2.1.1.4	EOB_MRI_AET_95B
9.6A	2.2.5	4.2	1.3.76.2.1.1.4	EOB_MRI_AET_96A

4   NETWORKING

4.1   IMPLEMENTATION MODEL

4.1.1   Application Data Flow
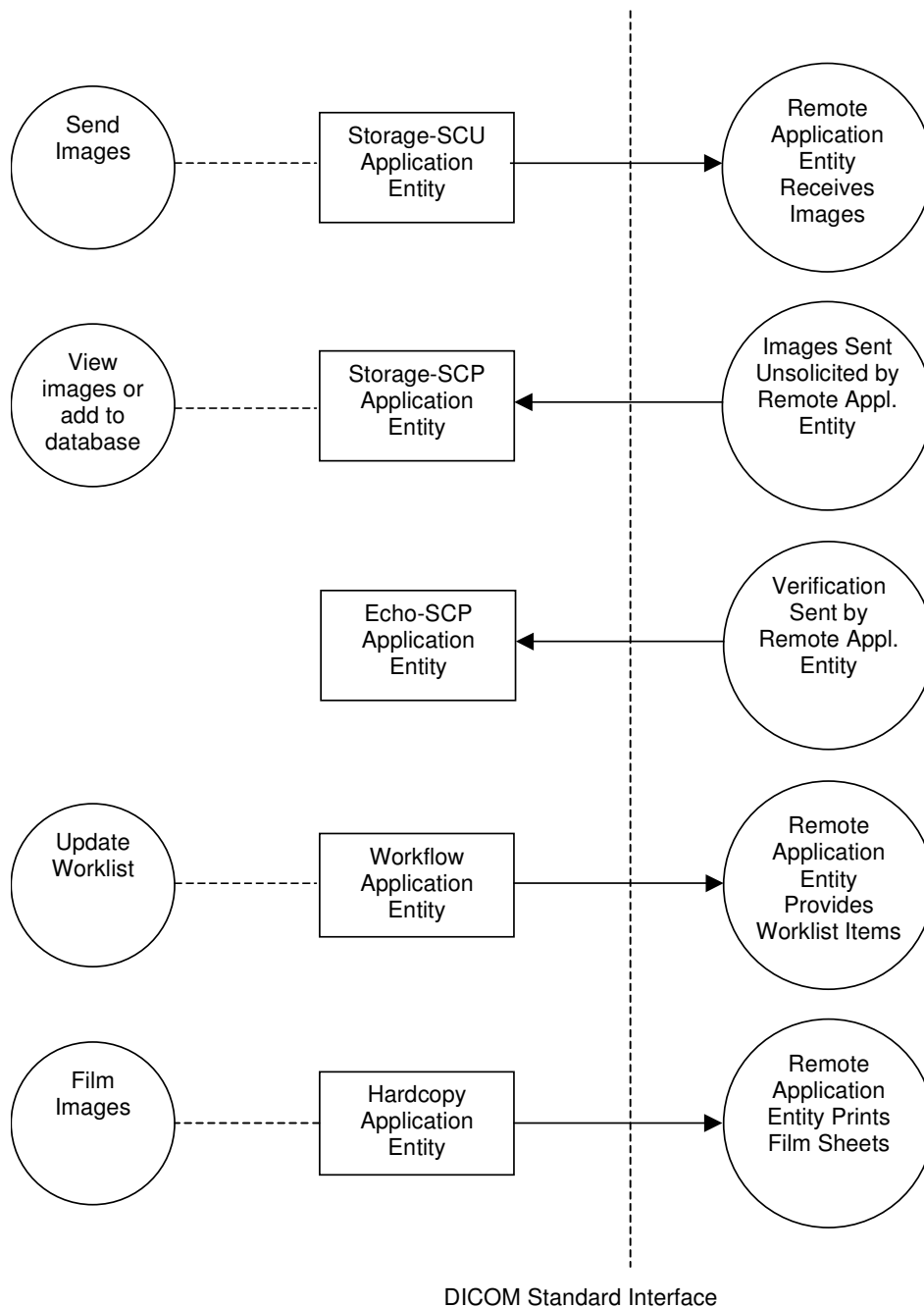
Figure 1
APPLICATION DATA FLOW DIAGRAM

— The Storage-SCU Application Entity sends images to a remote AE. It is associated with the local real-
world activity "Send Images". "Send Images" is performed upon user request for each study completed
or for specific series selected from the Patient Database. The Auto Send feature, when activated by
the user's settings, immediately stores every acquired series of images to one or more preferred
destinations.

— The Storage-SCP Application Entity receives images from a remote AE. The received images are put in a temporary storage area, from where they can be reviewed, deleted, or moved to the local database.

— The Echo-SCP Application Entity responds to verification requests from a remote AE.

— The Workflow Application Entity receives Worklist information from a remote AE. It is associated with the local real-world activity "Update Worklist". When the "Update Worklist" local real-world activity is performed the Workflow Application Entity queries a remote AE for worklist items and provides the set of worklist items matching the query request. "Update Worklist" is performed as a result of an operator request or can be performed automatically to refresh the worklist item when starting an exam.

— The Hardcopy Application Entity prints images on a remote AE (DICOM Printer). It is associated with the local real-world activity "Film Images". "Film Images" creates a print-job within the print queue containing one virtual film sheet composed from images selected by the user.

4.1.2 Functional Definition of AEs

4.1.2.1 Functional Definition of Storage-SCU Application Entity

The existence of a send-job queue entry with associated network destination will activate the Storage-SCU AE. An association request is sent to the destination AE and upon successful negotiation of a Presentation Context the image transfer is started. If the association cannot be opened, or an error is reported for some of the instances, the related instances are set to an error state (Aborted) and can be re-sent by the user via job control interface: it is possible to re-send to the same or to another pre-configured destination either an aborted or a successfully sent group of instances (see the User's Manual). The Storage AE will not try to initiate another association for the send-job automatically.

4.1.2.2 Functional Definition of Storage-SCP Application Entity

The Storage-SCP AE waits in the background for connections, will accept associations with Presentation Contexts for SOP Classes of the Storage Service Class, and will store the received instances to a temporary storage area, where they can be reviewed, deleted or moved to the local database through the user interface.

4.1.2.3 Functional Definition of Echo-SCP Application Entity

Echo-SCP AE waits in the background for connections, will accept associations with Presentation Contexts for SOP Class of the Verification Service Class, and will respond successfully to echo requests.

4.1.2.4 Functional Definition of Workflow Application Entity

Worklist Update attempts to download a Worklist from a remote node. If the Workflow AE establishes an Association to a remote AE, it will transfer all worklist items via the open Association.

4.1.2.5 Functional Definition of Hardcopy Application Entity

The existence of a print-job in the print queue will activate the Hardcopy AE. An association is established with the printer. If the association cannot be opened, a message appears and it is possible to retry or to abort the printing of the current film. After opening the association the printer's status is determined. If the printer is operating normally, the film sheet described within the print-job will be printed. Changes in printer status will be detected (e.g. out of film) and reported to the user. If the printer is not operating normally, in case of Warning the status is reported to the user, and it is possible to continue sending the print-job data; in case of Failure the print-job will be set to an error state.

4.1.3　　　Sequencing of Real-World Activities
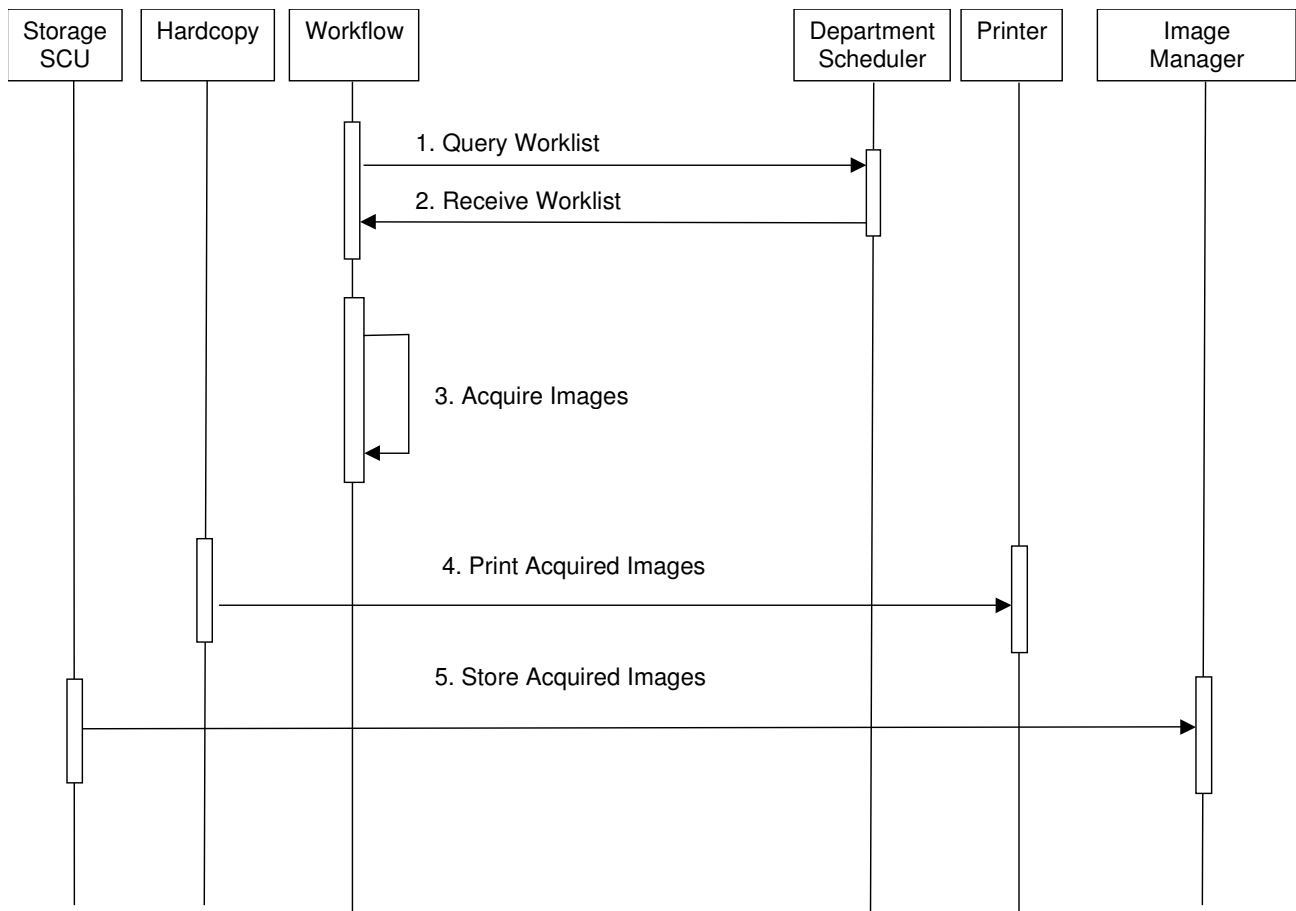
Figure 2
SEQUENCING CONSTRAINTS

Under normal scheduled workflow conditions the sequencing constraints illustrated in Figure 2 apply:

1. Query Worklist.

2. Receive Worklist of Modality Scheduled Procedure Steps (MSPS) and select Workitem (MSPS) from Worklist.

3. Acquire Images.

4. Print acquired images (optional step).

5. Store acquired images.

Other workflow situations (e.g. unscheduled procedure steps, receive images) will have other sequencing constraints. Printing could equally take place after the acquired images have been stored. Printing could be omitted completely if no printer is connected or hardcopies are not required.

4.2 AE SPECIFICATIONS

4.2.1 Storage-SCU Application Entity Specification

4.2.1.1 SOP Classes

The Storage-SCU AE provides Standard Conformance to the following SOP Classes:

Table 5
SOP CLASSES FOR STORAGE-SCU AE

SOP Class Name	SOP Class UID	SCU	SCP
MR Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.4	Yes	No

4.2.1.2 Association Policies

4.2.1.2.1 General

The DICOM standard application context name for DICOM 3.0 is always proposed:

Table 6
DICOM APPLICATION CONTEXT FOR STORAGE-SCU AE

Application Context Name	1.2.840.10008.3.1.1.1

4.2.1.2.2 Number of Associations

The Storage-SCU AE initiates one Association at a time. Only one job will be active at a time, the other remains pending until the active job is completed or failed.

Table 7
NUMBER OF ASSOCIATIONS INITIATED FOR STORAGE-SCU AE

Maximum number of simultaneous Associations	1

The Storage-SCU AE does not accept Associations.

Table 8
NUMBER OF ASSOCIATIONS ACCEPTED FOR STORAGE-SCU AE

Maximum number of simultaneous Associations	0

4.2.1.2.3 Asynchronous Nature

The Storage-SCU AE does not support asynchronous communication (multiple outstanding transactions over a single Association).

Table 9
ASYNCHRONOUS NATURE AS A SCU FOR STORAGE-SCU AE

Maximum number of outstanding asynchronous transactions	1

4.2.1.2.4 Implementation Identifying Information

The implementation information for this Application Entity can be found in Table 4.

4.2.1.3 Association Initiation Policy

4.2.1.3.1 Activity – Send Images

4.2.1.3.1.1. Description and Sequencing of Activities

A user can select one or more series of images, or one or more studies of the same patient, or one or more patients and request them to be sent to a destination. Each request is forwarded to the job queue and processed individually. When the "Auto-send" option is active, each acquired series of instances will be

forwarded to the network job queue for a set of pre-configured auto-send target destinations. The "Auto-send" is triggered by the end of the series acquisition.

The Storage-SCU AE is invoked by the job control interface that is responsible for processing network archival tasks. The job consists of data describing the instances marked for storage and the destination. An internal thread triggered by a job for a specific network destination initiates a C-STORE request to store images. If the process successfully establishes an Association to a remote Application Entity, it will transfer each marked instance one after another via the open Association. Status of the transfer is reported through the job control interface. Only one job will be active at a time. If the C-STORE Response from the remote Application contains a status other than Success or Warning, the instance that generated the error is marked and the job execution goes to the next instance. It can be restarted any time by user interaction. If the job contains multiple images then multiple C-STORE requests will be issued over the same Association.
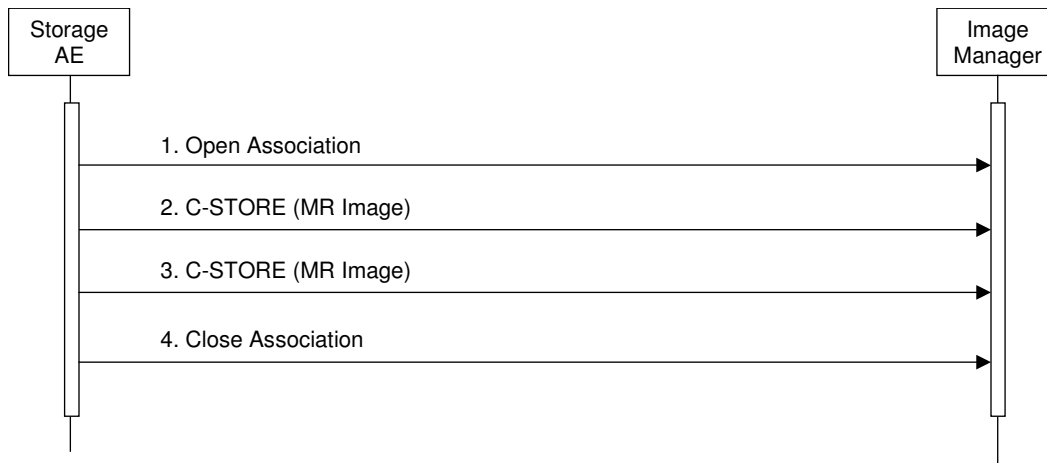
Figure 3
SEQUENCING OF ACTIVITY – SEND IMAGES

A possible sequence of interactions between the Storage-SCU AE and an Image Manager (e.g. a storage or archive device supporting the Storage and Storage Commitment SOP Classes as an SCP) is illustrated in Figure 3:

1. The Storage-SCU AE opens an association with the Image Manager

2. An acquired MR image is transmitted to the Image Manager using a C-STORE request and the Image Manager replies with a C-STORE response (status success).

3. Another acquired MR image is transmitted to the Image Manager using a C-STORE request and the Image Manager replies with a C-STORE response (status success).

4. The Storage-SCU AE closes the association with the Image Manager.

NOTE: Many other message sequences are possible depending on the number of images to be stored.

4.2.1.3.1.2.   Proposed Presentation Contexts
The ESAOTE MRI system Storage-SCU AE is capable of proposing the Presentation Contexts shown in the following table:

Table 10
PROPOSED PRESENTATION CONTEXTS FOR ACTIVITY SEND IMAGES

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
MR Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian Explicit VR Little Endian Explicit VR Big Endian[3]	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2	SCU	None

4.2.1.3.1.3.   SOP Specific Conformance Image Storage SOP Classes

All Image SOP Classes supported by the Storage-SCU AE exhibit the same behavior, except where stated, and are described together in this section.

The behavior of Storage-SCU AE when encountering status codes in a C-STORE response is summarized in the Table below:

Table 11
STORAGE-SCU AE C-STORE RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The SCP has successfully stored the SOP Instance. The SOP Instance is marked as sent.
*	*	Any other status code.	The failed SOP instance is marked as aborted. The status meaning is reported to the user and logged.

The behavior of Storage-SCU AE during communication failure is summarized in the Table below:

Table 12
STORAGE COMMUNICATION FAILURE BEHAVIOR

Exception	Behavior
Timeout	The instances are marked as failed. The reason is logged and reported to the user.
Association aborted by the SCP or network layers	The instances are marked as failed. The reason is logged and reported to the user.

A failed send job can be restarted by user interaction.

The contents of MR Image Storage SOP Instances created by The ESAOTE MRI system conform to the DICOM MR Image IOD definition and are described in section 8.1.

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[3] No more offered starting with the 9.4A software releases.

4.2.2   Storage-SCP Application Entity Specification

4.2.2.1   SOP Classes

Storage-SCP AE provides Standard Conformance to the following SOP Class(es):

Table 13
SOP CLASSES SUPPORTED BY STORAGE-SCP AE

SOP Class Name	SOP Class UID	SCU	SCP
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	No	Yes

4.2.2.2   Association Policies

4.2.2.2.1   General

Storage-SCP accepts but never initiates associations.

Table 14
MAXIMUM PDU SIZE RECEIVED AS A SCP FOR STORAGE-SCP AE

Maximum PDU size received	28672

4.2.2.2.2   Number of Associations

Table 15
NUMBER OF ASSOCIATIONS AS A SCP FOR STORAGE-SCP AE

Maximum number of simultaneous associations	20

4.2.2.2.3   Asynchronous Nature

Storage-SCP AE will only allow a single outstanding operation on an Association. Therefore, Storage-SCP AE will not perform asynchronous operations window negotiation.

4.2.2.2.4   Implementation Identifying Information

The implementation information for this Application Entity can be found in Table 4.

4.2.2.3   Association Initiation Policy

The Storage-SCP does not initiate associations.

4.2.2.4   Association Acceptance Policy

When Storage-SCP AE accepts an association, it will respond to storage requests. If the Called AE Title does not match the pre-configured local AE Title shared by all the SCPs of the application, the association will be rejected.

4.2.2.4.1   Activity – Receive Storage Request

4.2.2.4.1.1.   Description and Sequencing of Activities

As instances are received they are copied in a temporary storage area of the local file system. If the received instance is a duplicate of a previously received instance, the old file and database record will be kept instead of the new one.

4.2.2.4.1.2. Accepted Presentation Contexts

Table 16
ACCEPTABLE PRESENTATION CONTEXTS FOR
STORAGE-SCP AE RECEIVED STORAGE REQUESTS

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended
Name	UID	Name	UID		Negotiation
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
		Explicit VR Big Endian[3]	1.2.840.10008.1.2.2	SCP	None

The Presentation Contexts are accepted in the preference order described in the above table; as Implicit VR Little Endian must be offered by default, it will always be the accepted one.

Extended Negotiation

No extended negotiation is performed, though Storage-SCP AE:

— is a Level 2 Storage SCP (Full – does not discard any data elements);

— does not support digital signatures;

— does not coerce any received data elements.

4.2.2.4.1.3. SOP Specific Conformance

SOP Specific Conformance to Storage SOP Classes

Storage-SCP AE provides standard conformance to the Storage Service Class.

Presentation Context Acceptance Criterion

Storage-SCP AE will always accept any Presentation Context for the supported SOP Classes with the supported Transfer Syntaxes. More than one proposed Presentation Context will be accepted for the same Abstract Syntax if the Transfer Syntax is supported, whether or not it is the same as another Presentation Context.

Transfer Syntax Selection Policies

Storage-SCP AE accepts the default Transfer Syntax. If offered a choice of Transfer Syntaxes in a Presentation Context, it will apply the following priority to the choice of Transfer Syntax:

a. default Transfer Syntax
b. explicit Little Endian

Storage-SCP AE will accept duplicate Presentation Contexts, that is, if it is offered multiple Presentation Contexts, each of which offers acceptable Transfer Syntaxes, it will accept all Presentation Contexts, applying the same priority for selecting a Transfer Syntax for each.

Response Status

Storage-SCP AE will behave as described in the Table below when generating the C-STORE response command message.

Table 17
RESPONSE STATUS FOR STORAGE-SCP AE RECEIVED STORAGE REQUESTS

Service Status	Further Meaning	Status Codes	Reason
Refused	Out of Resources	A700	Sent when the maximum number of images in the temporary storage area is exceeded, or the local hard disk is full.
Error	Data Set does not match SOP Class	A900	Never sent – data set is not checked prior to storage.
	Cannot understand	C000	Sent when receiving instances with offending elements.
Warning	Coercion of Data Elements	B000	Never sent - no coercion is ever performed.
	Data Set does not match SOP Class	B007	Never sent - data set is not checked prior to storage.
	Elements Discarded	B006	Never sent – all elements are always stored.
Success		0000	

4.2.3   Echo-SCP Application Entity Specification

4.2.3.1   SOP Classes

Echo-SCP AE provide Standard Conformance to the following SOP Class(es):

Table 18
SOP CLASSES SUPPORTED BY ECHO-SCP AE

SOP Class Name	SOP Class UID	SCU	SCP
Verification SOP Class	1.2.840.10008.1.1	No	Yes

4.2.3.2   Association Policies

4.2.3.2.1   General

Echo-SCP AE accepts but never initiates associations.

Table 19
MAXIMUM PDU SIZE RECEIVED AS A SCP FOR ECHO-SCP AE

Maximum PDU size received	28672

4.2.3.2.2   Number of Associations

Table 20
NUMBER OF ASSOCIATIONS AS A SCP FOR ECHO-SCP AE

Maximum number of simultaneous associations	20

4.2.3.2.3   Asynchronous Nature

Echo-SCP AE will only allow a single outstanding operation on an Association. Therefore, Echo-SCP AE will not perform asynchronous operations window negotiation.

4.2.3.2.4   Implementation Identifying Information

The implementation information for this Application Entity can be found in Table 4.

4.2.3.3   Association Initiation Policy

Echo-SCP AE does not initiate associations.

4.2.3.4   Association Acceptance Policy

When Echo-SCP AE accepts an association, it will respond to echo requests. If the Called AE Title does not match the pre-configured AE Title shared by all the SCPs of the application, the association will be rejected.

4.2.3.4.1   Activity – Receive Echo Request

4.2.3.4.1.1.   Description and Sequencing of Activities

4.2.3.4.1.2.   Accepted Presentation Contexts

Table 21
ACCEPTABLE PRESENTATION CONTEXTS FOR ECHO-SCP AE RECEIVE ECHO REQUEST

Presentation Context Table						
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**	
Name	**UID**	**Name**	**UID**			
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None	
		Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None	
		Explicit VR Big Endian[3]	1.2.840.10008.1.2.2	SCP	None	

The Presentation Contexts are accepted in the preference order described in the above table; as Implicit VR Little Endian must be offered by default, it will always be the accepted one.

Extended Negotiation

No extended negotiation is performed.

4.2.3.4.1.3.   SOP Specific Conformance

SOP Specific Conformance to Verification SOP Class

Echo-SCP AE provides standard conformance to the Verification Service Class.

Presentation Context Acceptance Criterion

Echo-SCP AE will always accept any Presentation Context for the supported SOP Classes with the supported Transfer Syntaxes. More than one proposed Presentation Context will be accepted for the same Abstract Syntax if the Transfer Syntax is supported, whether or not it is the same as another Presentation Context.

Transfer Syntax Selection Policies

Echo-SCP AE prefers explicit Transfer Syntaxes. If offered a choice of Transfer Syntaxes in a Presentation Context, it will apply the following priority to the choice of Transfer Syntax:

a.   first encountered explicit Transfer Syntax,
b.   default Transfer Syntax.

Echo-SCP AE will accept duplicate Presentation Contexts, that is, if it is offered multiple Presentation Contexts, each of which offers acceptable Transfer Syntaxes, it will accept all Presentation Contexts, applying the same priority for selecting a Transfer Syntax for each.

4.2.4   Workflow Application Entity Specification

4.2.4.1   SOP Classes

The ESAOTE MRI system provides Standard Conformance to the following SOP Classes:

Table 22
SOP CLASSES FOR AE WORKFLOW

SOP Class Name	SOP Class UID	SCU	SCP
Modality Worklist Information Model – FIND	1.2.840.10008.5.1.4.31	Yes	No

4.2.4.2   Association Policies

4.2.4.2.1   General

The DICOM standard application context name for DICOM 3.0 is always proposed:

Table 23
DICOM APPLICATION CONTEXT FOR AE WORKFLOW

Application Context Name	1.2.840.10008.3.1.1.1

4.2.4.3   Number of Associations

The ESAOTE MRI system initiates one Association at a time for a Worklist request.

Table 24
NUMBER OF ASSOCIATIONS INITIATED FOR AE WORKFLOW

Maximum number of simultaneous Associations	1

4.2.4.3.1   Asynchronous Nature

The ESAOTE MRI system does not support asynchronous communication (multiple outstanding transactions over a single Association).

Table 25
ASYNCHRONOUS NATURE AS A SCU FOR AE WORKFLOW

Maximum number of outstanding asynchronous transactions	1

4.2.4.3.2   Implementation Identifying Information

The implementation information for this Application Entity can be found in Table 4.

4.2.4.4   Association Initiation Policy

4.2.4.4.1   Activity – Worklist Update

4.2.4.4.1.1.   Description and Sequencing of Activities

The request for a Worklist Update is initiated by user interaction, i.e. pressing the button "Worklist" (broad query) or automatically when starting an exam selected among the previously requested worklist items (narrow query). With the "Worklist" button a dialog to enter search criteria is opened and an interactive query can be performed. When the Query is started on user request, the data from the dialog will be inserted as matching keys into the query.

With broad worklist queries the ESAOTE MRI system always requests all items that match the matching keys in the table below:

Table 26
BROAD WORKLIST QUERY MATCHING KEYS

Tag	Attribute	Contents
(0040,0002)	Scheduled Procedure Step Start Date	present date, can be modified
(0008,0060)	Modality	always *MR*
(0040,0001)	Scheduled Station AE Title	Local AE Title, can be modified

Upon initiation of the request, the ESAOTE MRI system will build an Identifier for the C-FIND request, using the above matching keys and the return keys in Table 31. Then it will initiate an Association to send the request and will wait for Worklist responses. After retrieval of all responses, the ESAOTE MRI system will prepare a list of the Scheduled Procedure Steps found in the responses.

When starting an exam with the data selected from the worklist responses, a narrow worklist query will be sent requesting the item that fulfills the matching keys in the table below:

Table 27
NARROW WORKLIST QUERY MATCHING KEYS

Tag	Attribute	Contents	Matching Key Type
(0040,0002)	Scheduled Procedure Step Start Date	the same used in the broad query	R
(0008,0060)	Modality	always *MR*	R
(0040,0001)	Scheduled Station AE Title	the same used in the broad query	R
(0040,0009)	Scheduled Procedure Step ID	from the selected result of the broad query	O
(0020,000D)	Study Instance UID	from the selected result of the broad query	O

Upon initiation of the request, the ESAOTE MRI system will build an Identifier for the C-FIND request, using the above matching keys and the return keys in Table 31. Then it will initiate an Association to send the request and will wait for Worklist responses. After retrieval of all responses, the ESAOTE MRI system filter them for the same Scheduled Procedure Step ID and Study Instance UID (that could not be supported by the SCP, see the table above), in order to identify the response that matches with the item selected in the broad query, then the data for the exam to be started are refreshed with the data received with the narrow query.

If from the narrow query, after filtering the responses as above, there are none or more than one matching items, or some of the relevant information in the return keys have changed since the broad query, a warning message will be shown.

For both the broad and narrow queries, the ESAOTE MRI system will initiate an Association in order to issue a C-FIND request according to the Modality Worklist Information Model.
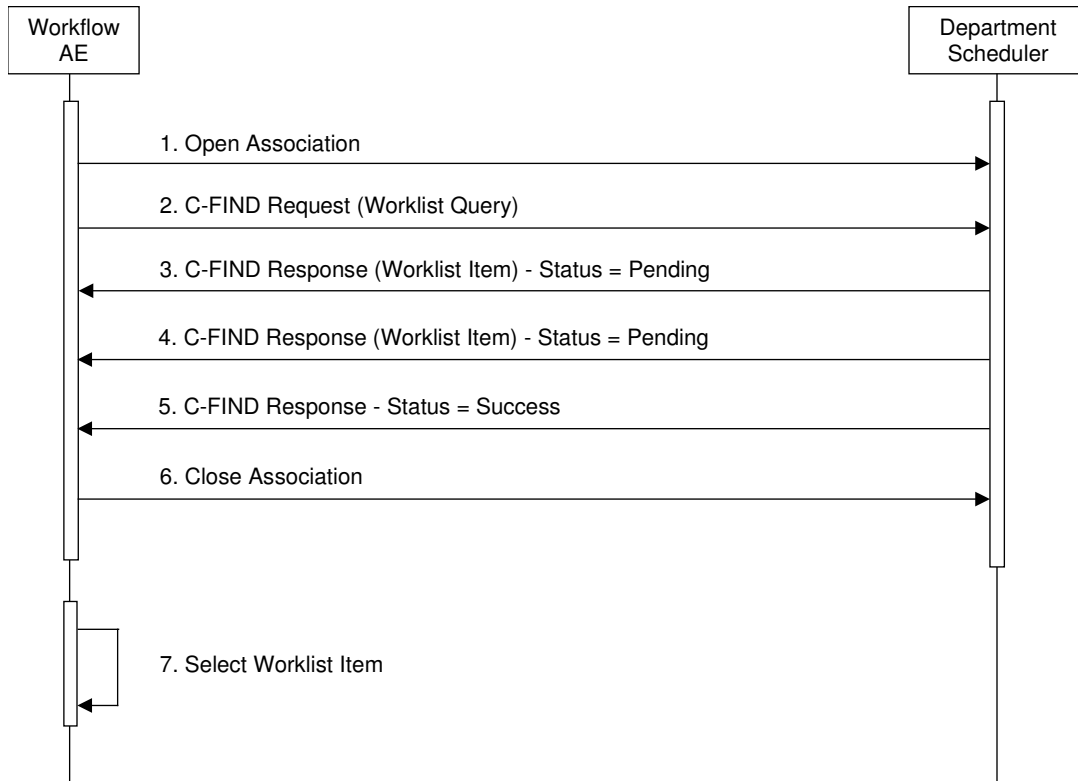
Figure 4
SEQUENCING OF ACTIVITY – WORKLIST UPDATE

A possible sequence of interactions between the Workflow AE and a Departmental Scheduler (e.g. a device such as a RIS or HIS which supports the Modality Worklist SOP Class as an SCP) is illustrated in the Figure above:

1. The Worklist AE opens an association with the Departmental Scheduler

2. The Worklist AE sends a C-FIND request to the Departmental Scheduler containing the Worklist Query attributes.

3. The Departmental Scheduler returns a C-FIND response containing the requested attributes of the first matching Worklist Item.

4. The Departmental Scheduler returns another C-FIND response containing the requested attributes of the second matching Worklist Item.

5. The Departmental Scheduler returns another C-FIND response with status Success indicating that no further matching Worklist Items exist. This example assumes that only 2 Worklist items match the Worklist Query.

6. The Worklist AE closes the association with the Departmental Scheduler.

7. The user selects a Worklist Item from the Worklist and prepares to acquire new images.

4.2.4.4.1.2.   Proposed Presentation Contexts

The ESAOTE MRI system will propose Presentation Contexts as shown in the following table:

Table 28
PROPOSED PRESENTATION CONTEXTS FOR ACTIVITY WORKLIST UPDATE

Presentation Context Table					
Abstract Syntax		Transfer Syntax			Ext. Neg.
Name	UID	Name List	UID List	Role	
Modality Worklist Information Model – FIND	1.2.840.10008.5.1.4.31	Implicit VR Little Endian Explicit VR Little Endian Explicit VR Big Endian[3]	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2	SCU	None

4.2.4.4.1.3.   SOP Specific Conformance for Modality Worklist

The behavior of the ESAOTE MRI system when encountering status codes in a Modality Worklist C-FIND response is summarized in the Table below. If any other SCP response status than "Success" or "Pending" is received by the ESAOTE MRI, a message "query failed" will appear on the user interface.

Table 29
MODALITY WORKLIST C-FIND RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Matching is complete	0000	The SCP has completed the matches. Worklist items are available for display or further processing.
Refused	Out of Resources	A700	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.
Failed	Identifier does not match SOP Class	A900	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.
Failed	Unable to Process	C000 – CFFF	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.
Cancel	Matching terminated due to Cancel request	FE00	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.
Pending	Matches are continuing	FF00	The worklist item contained in the Identifier is collected for later display or further processing.
Pending	Matches are continuing – Warning that one or more Optional Keys were not supported	FF01	The worklist item contained in the Identifier is collected for later display or further processing. The status meaning is logged.
*	*	Any other status code.	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.

The behavior of the ESAOTE MRI system during communication failure is summarized in the Table below.

Table 30
MODALITY WORKLIST COMMUNICATION FAILURE BEHAVIOR

Exception	Behavior
Timeout	The Association is aborted and the worklist query marked as failed. The reason is logged and reported to the user.
Association aborted by the SCP or network layers	The worklist query is marked as failed. The reason is logged and reported to the user.

Acquired images will always use the Study Instance UID specified for the Scheduled Procedure Step (if available). If an acquisition is unscheduled, a Study Instance UID will be generated locally.

The Table below provides a description of the ESAOTE MRI Worklist Request Identifier and specifies the attributes that are copied into the images. Unexpected attributes returned in a C-FIND response are ignored.

Requested return attributes not supported by the SCP are set to have no value. Non-matching responses returned by the SCP due to unsupported optional matching keys are ignored. Possible duplicate entries are filtered and an information message is given to the User.

When in the response one of the following type 1 attributes is missing an error is reported to the User and the worklist item is discarded:

- (0010,0010)   Patient's Name (only the first component, Family Name, is requested)

- (0010,0020)   Patient ID

- (0020,000D)   Study Instance UID

- (0040,1001)   Requested Procedure ID

- (0040,0100)   Scheduled Procedure Step Sequence

- (0040,0002)   Scheduled Procedure Step Start Date

- (0040,0003)   Scheduled Procedure Step Start Time

- (0040,0009)   Scheduled Procedure Step ID

- (0040,0001)   Scheduled station AE title

- (0008,0060)   Modality

Table 31
WORKLIST REQUEST IDENTIFIER

Module Name / Attribute Name	Tag	VR	M	R	Q	D	IOD
SOP Common							
Specific Character Set	(0008,0005)	CS		x			
Scheduled Procedure Step							
Scheduled Procedure Step Sequence	(0040,0100)	SQ		x			
> Scheduled Station AET	(0040,0001)	AE	(S)			x	
> Scheduled Procedure Step Start Date	(0040,0002)	DA	R			x	
> Scheduled Procedure Step Start Time	(0040,0003)	TM		x		x	
> Modality	(0008,0060)	CS	S	x			x
> Scheduled Procedure Step Description	(0040,0007)	LO		x		x	x
> Scheduled Protocol Code Sequence	(0040,0008)	SQ		x		x	x
> Scheduled Procedure Step ID	(0040,0009)	SH		x		x	x
Requested Procedure							

Module Name	Tag	VR	M	R	Q	D	IOD
Attribute Name							
Requested Procedure ID	(0040,1001)	SH		x	x	x	x
Requested Procedure Description	(0032,1060)	LO		x		x	
Study Instance UID	(0020,000D)	UI		x			x
Referenced Study Sequence	(0008,1110)	SQ		x			x
Requested Procedure Code Sequence	(0032,1064)	SQ		x		x	
Imaging Service Request							
Accession Number	(0008,0050)	SH		x	x	x	x
Referring Physician's Name	(0008,0090)	PN		x		x	x
Visit Admission							
Admitting Diagnoses Description	(0008,1080)	LO		x		x	x
Patient Identification							
Patient's Name	(0010,0010)	PN		x	x	x	x
Patient ID	(0010,0020)	LO		x		x	x
Patient Demographic							
Patient's Birth Date	(0010,0030)	DA		x		x	x
Patient's Sex	(0010,0040)	CS		x		x	x
Patient's Size	(0010,1020)	DS		x			x
Patient's Weight	(0010,1030)	DS		x			x
Occupation	(0010,2180)	LO		x			x
Patient Comments	(0010,4000)	LT		x			x
Patient Medical							
Additional Patient History	(0010,21B0)	LT		x		x	x

The above table should be read as follows:

Module Name: The name of the associated module for supported worklist attributes.

Attribute Name: Attributes supported to build an ESAOTE MRI system Worklist Request Identifier.

Tag: DICOM tag for this attribute.

VR: DICOM VR for this attribute.

M: Matching keys for Worklist Update. A "S" will indicate that the ESAOTE MRI system will supply an attribute value for Single Value Matching, a "R" will indicate Range Matching and a "*" will denote wildcard matching. "Scheduled Station AE Title" is set to the Local AET but can be modified by the user "(S)", and Modality is set to MR.

R: Return keys. An "x" will indicate that the ESAOTE MRI system will supply this attribute as Return Key with zero length for Universal Matching.

Q: Interactive Query Key (broad query). An "x" " will indicate that the ESAOTE MRI system will supply this attribute as matching key, if entered in the Worklist dialog. For example, the Patient Name can be entered thereby restricting Worklist responses to Procedure Steps scheduled for the patient.

D: Displayed keys. An "x" indicates that this worklist attribute is displayed to the user during a patient registration dialog. For example, Patient Name will be displayed when registering the patient prior to an examination.

IOD: An "x" indicates that this Worklist attribute is included into all Object Instances created during performance of the related Procedure Step.

4.2.4.5   Association Acceptance Policy

The Workflow Application Entity does not accept Associations.

4.2.5   Hardcopy Application Entity Specification

4.2.5.1   SOP Classes

The ESAOTE MRI system provides Standard Conformance to the following SOP Classes:

Table 32
SOP CLASSES FOR AE HARDCOPY

SOP Class Name	SOP Class UID	SCU	SCP
Basic Grayscale Print Management Meta	1.2.840.10008.5.1.1.9	Yes	No

4.2.5.2   Association Policies

4.2.5.2.1   General

The DICOM standard application context name for DICOM 3.0 is always proposed:

Table 33
DICOM APPLICATION CONTEXT FOR AE HARDCOPY

Application Context Name	1.2.840.10008.3.1.1.1

4.2.5.2.2   Number of Associations

The ESAOTE MRI system initiates one Association at a time for each configured hardcopy device. Multiple hardcopy devices can be configured.

Table 34
NUMBER OF ASSOCIATIONS INITIATED FOR AE HARDCOPY

Maximum number of simultaneous Associations	number of configured hardcopy devices

4.2.5.2.3   Asynchronous Nature

The ESAOTE MRI system does not support asynchronous communication (multiple outstanding transactions over a single Association).

Table 35
ASYNCHRONOUS NATURE AS A SCU FOR AE HARDCOPY

Maximum number of outstanding asynchronous transactions	1

4.2.5.2.4   Implementation Identifying Information

The implementation information for this Application Entity can be found in Table 4.

4.2.5.2.5   Printer configuration

The System Administrator, when configuring the ESAOTE MRI system for a given DICOM printer, must select a suitable Printer Profile, according to the brand/model of the printer. In the Printer Profile, compiled using the DICOM Conformance Statement of the printer, for every attribute that can be put in the N-CREATE of the Film Session SOP Class, in the N-CREATE of the Film Box SOP Class and in the N-SET on the Image Box SOP Class, there is the complete list of accepted values, and the most suitable one (or a flag that says not to send this attribute, for the optional ones). Some of these attributes can be changed by the User among the ones present in the Printer Profile, while for the others the most suitable one (or none) will be sent, according to the Printer Profile. There is also a generic Printer Profile, in which all the non-mandatory information is marked not to be sent: this Printer Profile can be used with unknown printers, leaving the printer software the burden to chose the most correct configuration parameters.

4.2.5.3   Association Initiation Policy

4.2.5.3.1   Activity – Film Images

4.2.5.3.1.1.   Description and Sequencing of Activities

A user composes images onto one film sheet and requests it to be sent to a specific hardcopy device. The user can select the desired film format, film size and number of copies. Each print-job is forwarded to the job queue and processed individually.

The Hardcopy AE is invoked by the job control interface that is responsible for processing network tasks. The job consists of data describing the images and graphics to be printed as well as the requested layout and other parameters. The film sheet is sent image by image. If no association to the printer can be established, the print-job is switched to a failed state and the user informed.
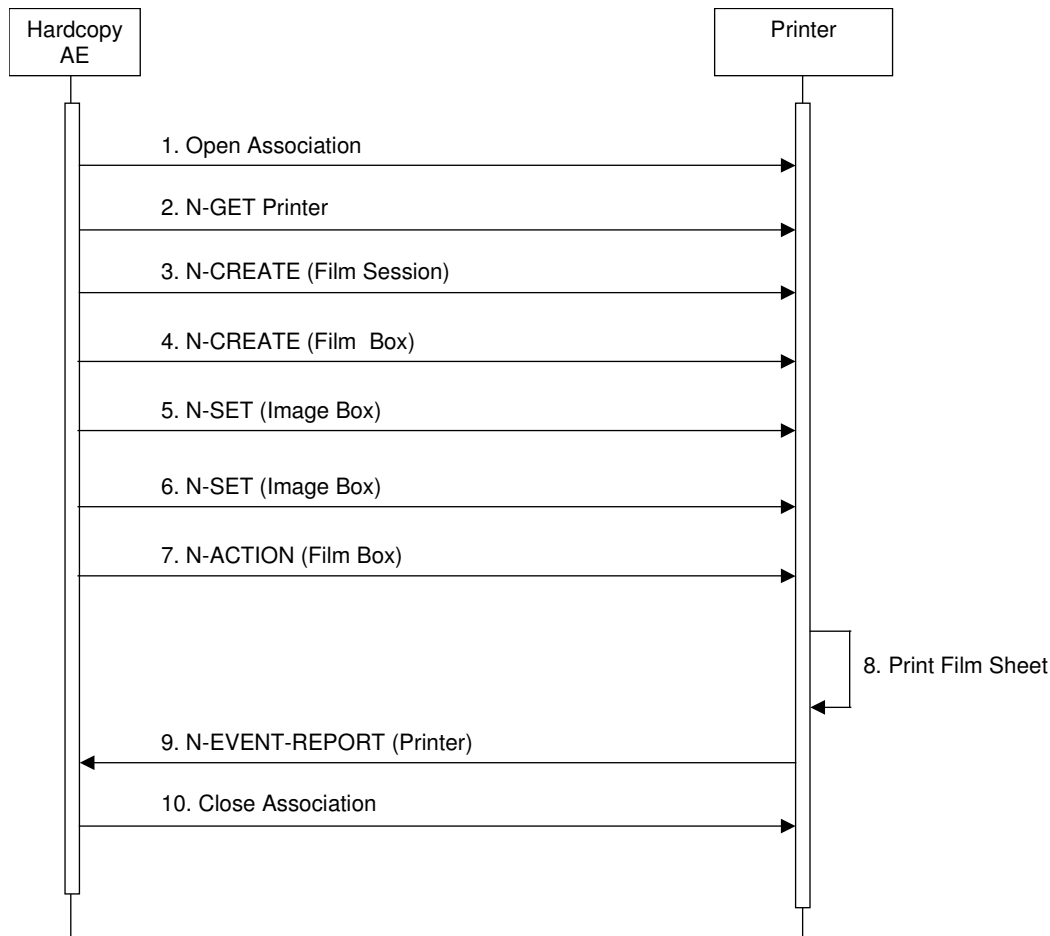
Figure 5
SEQUENCING OF ACTIVITY – FILM IMAGES

A typical sequence of DIMSE messages sent over an association between Hardcopy AE and a Printer is illustrated in Figure 5:

1.   Hardcopy AE opens an association with the Printer

2.   N-GET on the Printer SOP Class is used to obtain current printer status information. If the Printer reports a status of FAILURE, the print-job is switched to a failed state and the user informed.

3.   N-CREATE on the Film Session SOP Class creates a Film Session.

4.   N-CREATE on the Film Box SOP Class creates a Film Box linked to the Film Session.

5.   N-SET on the Image Box SOP Class transfers the contents of the first image to the printer.

6. N-SET on the Image Box SOP Class transfers the contents of the other various images to the printer, or delete the unwanted ones from the Film Box.

7. N-ACTION on the Film Box SOP Class instructs the printer to print the Film Box already composed.

8. The printer prints the requested number of film sheets

9. The Printer asynchronously reports its status via N-EVENT-REPORT notification (Printer SOP Class). The printer can send this message at any time. Hardcopy AE does not require the N-EVENT-REPORT to be sent. Hardcopy AE is capable of receiving an N-EVENT-REPORT notification at any time during an association. If the Printer reports a status of FAILURE, the print-job is switched to a failed state and the user informed.

10. Hardcopy AE closes the association with the Printer

Status of the print-job is reported through the job control interface. Only one job will be active at a time for each separate hardcopy device. If any Response from the remote Application contains a status other than Success or Warning, the Association is aborted and the related Job is switched to a failed state.

4.2.5.3.1.2.   Proposed Presentation Contexts

The ESAOTE MRI system is capable of proposing the Presentation Contexts shown in the Table below:

Table 36
PROPOSED PRESENTATION CONTEXTS FOR ACTIVITY FILM IMAGES

Presentation Context Table					
Abstract Syntax		Transfer Syntax			Ext. Neg.
Name	UID	Name List	UID List	Role	
Basic Grayscale Print Management Meta	1.2.840.10008.5.1.1.9	Implicit VR Little Endian Explicit VR Little Endian Explicit VR Big Endian[3]	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2	SCU	None

4.2.5.3.1.3.   Common SOP Specific Conformance for all Print SOP Classes

The general behavior of Hardcopy AE during communication failure is summarized in the Table below. This behavior is common for all SOP Classes supported by Hardcopy AE.

Table 37
HARDCOPY COMMUNICATION FAILURE BEHAVIOR

Exception	Behavior
Timeout	The Association is aborted. The reason is logged and reported to the user.
Association aborted by the SCP or network layers	The Association is aborted. The reason is logged and reported to the user.

4.2.5.3.1.4.   SOP Specific Conformance for the Printer SOP Class

Hardcopy AE supports the following DIMSE operations and notifications for the Printer SOP Class:

— N-GET

— N-EVENT-REPORT

Details of the supported attributes and status handling behavior are described in the following subsections.

Printer SOP Class Operations (N-GET)

Hardcopy AE uses the Printer SOP Class N-GET operation to obtain information about the current printer status. The attributes obtained via N-GET are listed in the Table below:

Table 38
PRINTER SOP CLASS N-GET REQUEST ATTRIBUTES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Printer Status	(2110,0010)	CS	Provided by Printer	ALWAYS	Printer
Printer Status Info	(2110,0020)	CS	Provided by Printer	ALWAYS	Printer
Printer Name	(2110,0030)	LO	Provided by Printer (for logging purposes)	ALWAYS	Printer
Manufacturer	(0008,0070)	LO	Provided by Printer (for logging purposes)	ALWAYS	Printer
Manufacturer's Model Name	(0008,1090)	LO	Provided by Printer (for logging purposes)	ALWAYS	Printer
Device Serial Number	(0018,1000)	LO	Provided by Printer (for logging purposes)	ALWAYS	Printer
Software Version(s)	(0018,1020)	LO	Provided by Printer (for logging purposes)	ALWAYS	Printer
Date of Last Calibration	(0018,1200)	DA	Provided by Printer (for logging purposes)	ALWAYS	Printer
Time of Last Calibration	(0018,1201)	TM	Provided by Printer (for logging purposes)	ALWAYS	Printer

The Printer Status information is evaluated as follows:

1. If Printer status (2110,0010) is NORMAL, the print-job continues to be printed.

2. If Printer status (2110,0010) is FAILURE, the print-job is marked as failed. The contents of Printer Status Info (2110,0020) is logged and reported to the user.

3. If Printer status (2110,0010) is WARNING, the print-job continues to be printed. The contents of Printer Status Info (2110,0020) is logged and reported to the user.

The behavior of Hardcopy AE when encountering status codes in a N-GET response is summarized in the Table below:

Table 39
PRINTER SOP CLASS N-GET RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The request to get printer status information was success.
*	*	Any other status code.	The Association is aborted. The status meaning is logged and reported to the user.

Printer SOP Class Notifications (N-EVENT-REPORT)

Hardcopy AE is capable of receiving an N-EVENT-REPORT request at any time during an association.

The behavior of Hardcopy AE when receiving Event Types within the N-EVENT-REPORT is summarized in the Table below:

Table 40
PRINTER SOP CLASS N-EVENT-REPORT BEHAVIOUR

Event Type Name	Event Type ID	Behavior
Normal	1	The print-job continues to be printed.
Warning	2	The print-job continues to be printed. The contents of Printer Status Info (2110,0020) is logged and reported to the user.
Failure	3	The print-job is marked as failed. The contents of Printer Status Info (2110,0020) is logged and reported to the user.
*	*	An invalid Event Type ID will cause a status code of 0113H to be returned in a N-EVENT-REPORT response.

The reasons for returning specific status codes in a N-EVENT-REPORT response are summarized in the Table below:

Table 41
PRINTER SOP CLASS N-EVENT-REPORT RESPONSE STATUS REASONS

Service Status	Further Meaning	Error Code	Reasons
Success	Success	0000	The notification event has been successfully received.
Failure	No Such Event Type	0113H	An invalid Event Type ID was supplied in the N-EVENT-REPORT request.
Failure	Processing Failure	0110H	An internal error occurred during processing of the N-EVENT-REPORT. A short description of the error will be returned in Error Comment (0000,0902).

4.2.5.3.1.5.   SOP Specific Conformance for the Film Session SOP Class

Hardcopy AE supports the following DIMSE operations for the Film Session SOP Class:

— N-CREATE

Details of the supported attributes and status handling behavior are described in the following subsections.

Film Session SOP Class Operations (N-CREATE)

The attributes supplied in an N-CREATE Request are listed in the Table below:

Table 42
FILM SESSION SOP CLASS N-CREATE REQUEST ATTRIBUTES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Number of Copies	(2000,0010)	IS	Chosen by the User among the values in the Printer Profile.	ALWAYS	USER
Print Priority	(2000,0020)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Medium Type	(2000,0030)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Film Destination	(2000,0040)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Film Session Label	(2000,0050)	LO	Pre-defined value from the Printer Profile.	ANAP	PROFILE

| Memory Allocation | (2000,0060) | IS | Pre-defined value from the Printer Profile. | ANAP | PROFILE |
| Owner ID | (2100,0160) | SH | Pre-defined value from the Printer Profile. | ANAP | PROFILE |

The behavior of Hardcopy AE when encountering status codes in a N-CREATE response is summarized in the Table below:

Table 43
FILM SESSION SOP CLASS N-CREATE RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The SCP has completed the operation successfully.
Warning	Attribute Value Out of Range	0116H	The N-CREATE operation is considered successful and the user is notified that there was a warning. The status meaning and additional information in the Response identifying the attributes out of range will be logged (i.e. Elements in the Modification List/Attribute List).
Warning	Attribute List Error	0107H	The N-CREATE operation is considered successful and the user is notified that there was a warning. The status meaning and additional information in the Response identifying the attributes will be logged (i.e. Elements in the Attribute Identifier List).
*	*	Any other status code.	The Association is aborted and the print-job is marked as failed and the user is notified that there was an error. The status meaning is logged.

4.2.5.3.1.6.   SOP Specific Conformance for the Film Box SOP Class

Hardcopy AE supports the following DIMSE operations for the Presentation LUT SOP Class:

— N-CREATE

— N-ACTION

Details of the supported attributes and status handling behavior are described in the following subsections.

Film Box SOP Class Operations (N-CREATE)

The attributes supplied in an N-CREATE Request are listed in the Table below:

Table 44
FILM BOX SOP CLASS N-CREATE REQUEST ATTRIBUTES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Image Display Format	(2010,0010)	CS	Chosen by the User among the STANDARD\c,r values in present the Printer Profile.	ALWAYS	USER
Film Orientation	(2010,0040)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Film Size ID	(2010,0050)	CS	Chosen by the User among the values in the Printer Profile. Always present even if "SKIP" is present in the Printer Profile.	ALWAYS	USER
Magnification Type	(2010,0060)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Smoothing Type	(2010,0080)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Border Density	(2010,0100)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE

Empty Image Density	(2010,0110)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Max Density	(2010,0130)	US	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Min Density	(2010,0120)	US	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Trim	(2010,0140)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Configuration Information	(2010,0150)	ST	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Referenced Film Session Sequence	(2010,0500)	SQ		ALWAYS	AUTO
>Referenced SOP Class UID	(0008,1150)	UI	1.2.840.10008.5.1.1.1	ALWAYS	AUTO
>Referenced SOP Instance UID	(0008,1155)	UI	From created Film Session SOP Instance	ALWAYS	AUTO
Requested Resolution ID	(2020,0050)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE

The behavior of Hardcopy AE when encountering status codes in a N-CREATE response is summarized in the Table below:

Table 45
FILM BOX SOP CLASS N-CREATE RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The SCP has completed the operation successfully.
*	*	Any other status code.	The Association is aborted and the print-job is marked as failed. The status meaning is logged and reported to the user.

Film Box SOP Class Operations (N-ACTION)

An N-ACTION Request is issued to instruct the Print SCP to print the contents of the Film Box. The Action Reply argument in an N-ACTION response is not evaluated.

The behavior of Hardcopy AE when encountering status codes in a N-ACTION response is summarized in the Table below:

Table 46
FILM BOX SOP CLASS N-ACTION RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The SCP has completed the operation successfully. The film has been accepted for printing.
*	*	Any other status code.	The Association is aborted and the print-job is marked as failed. The status meaning is logged and reported to the user.

4.2.5.3.1.7.   SOP Specific Conformance for the Image Box SOP Class

Hardcopy AE supports the following DIMSE operations for the Image Box SOP Class:

— N-SET

Details of the supported attributes and status handling behavior are described in the following subsections.

Image Box SOP Class Operations (N-SET)

The attributes supplied in an N-SET Request are listed in the Table below:

Table 47
IMAGE BOX SOP CLASS N-SET REQUEST ATTRIBUTES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Magnification Type	(2010,0060)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Smoothing Type	(2010,0080)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Min Density	(2010,0120)	US	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Max Density	(2010,0130)	US	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Configuration Information	(2010,0150)	ST	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Image Position	(2020,0010)	US	According to the place in the Film Box	ALWAYS	AUTO
Basic Grayscale Image Sequence	(2020,0110)	SQ		ALWAYS	AUTO
>Samples Per Pixel	(0028,0002)	US	1	ALWAYS	AUTO
>Photometric Interpretation	(0028,0004)	CS	MONOCHROME2	ALWAYS	AUTO
>Rows	(0028,0010)	US	512	ALWAYS	AUTO
>Columns	(0028,0011)	US	512	ALWAYS	AUTO
>Bits Allocated	(0028,0100)	US	8	ALWAYS	AUTO
>Bits Stored	(0028,0101)	US	8	ALWAYS	AUTO
>High Bit	(0028,0102)	US	7	ALWAYS	AUTO
>Pixel Representation	(0028,0103)	US	0000H = unsigned integer.	ALWAYS	AUTO
>Pixel Data	(7FE0,0010)	OB	Pixels of rendered image	ALWAYS	AUTO
Polarity	(2020,0020)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Requested Image Size	(2020,0030)	DS	Pre-defined value from the Printer Profile.	ANAP	PROFILE
Requested Decimate/Crop Behavior	(2020,0040)	CS	Pre-defined value from the Printer Profile.	ANAP	PROFILE

The behavior of Hardcopy AE when encountering status codes in a N-SET response is summarized in the Table below:

Table 48
IMAGE BOX SOP CLASS N-SET RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The SCP has completed the operation successfully. Image successfully stored in Image Box.
*	*	Any other status code.	The Association is aborted and the print-job is marked as failed. The status meaning is logged and reported to the user.

4.2.5.4 Association Acceptance Policy

The Hardcopy Application Entity does not accept Associations.

4.3 NETWORK INTERFACES

4.3.1 Physical Network Interface

The ESAOTE MRI system supports a single network interface. One or both of the following physical network interfaces will be available depending on installed hardware options:

Table 49
SUPPORTED PHYSICAL NETWORK INTERFACES

Ethernet 100baseT
Ethernet 10baseT

4.3.2 Additional Protocols

The ESAOTE MRI system conforms to the System Management Profiles listed in the Table below. All requested transactions for the listed profiles and actors are supported. Support for optional transactions are listed in the Table below:

Table 50
SUPPORTED SYSTEM MANAGEMENT PROFILES

Profile Name	Actor	Protocols Used	Optional Transactions	Security Support
Network Address Management	DHCP Client	DHCP	N/A	
	DNS Client	DNS	N/A	

4.3.2.1 DHCP

DHCP can be used to obtain TCP/IP network configuration information. The default Windows 2000 DHCP client is used, if enabled by the System Administrator: please refer to the Windows 2000 documentation for further details.

4.3.2.2 DNS

DNS can be used for address resolution. If DHCP is not in use or the DHCP server does not return any DNS server addresses, the identity of the DNS servers can be configured by the System Administrator. If a DNS server is not in use, the numeric IP addresses need to be used.

4.4 CONFIGURATION

4.4.1 AE Title/Presentation Address Mapping

4.4.1.1 Local AE Titles

All local AEs use the same AE Title. The AE Title and the TCP/IP Ports for the local applications can be configured by the System Administrator.

Table 51
AE TITLE CONFIGURATION TABLE

Application Entity	Default AE Title	Default TCP/IP Port
Storage-SCU	NmrEsaote	Not Applicable
Storage-SCP	NmrEsaote	104
Echo-SCP	NmrEsaote	104
Workflow	NmrEsaote	Not Applicable
Hardcopy	NmrEsaote	Not Applicable

4.4.1.2   Remote AE Title/Presentation Address Mapping

The AE Title, host names and port numbers of remote applications are configured using the ESAOTE MRI System Administrator tools.

4.4.1.2.1   Storage-SCU

The ESAOTE MRI System Administrator tools must be used to set the AE Titles, port-numbers and host-names for the remote Storage SCPs. Multiple remote Storage SCPs can be defined.

4.4.1.2.2   Storage-SCP

The ESAOTE MRI User can enable or disable the Storage-SCP together with the Echo-SCP. Associations for the supported SOP Classes will be accepted from any calling AE Title.

4.4.1.2.3   Echo-SCP

The Echo-SCP is automatically enabled if the Storage-SCP is enabled. Associations for the supported SOP Classes will be accepted from any calling AE Title.

4.4.1.2.4   Workflow

The ESAOTE MRI System Administrator tools must be used to set the AE Title, port-number and host-names for the remote Modality Worklist SCP. Multiple remote Worklist SCPs can be defined.

4.4.1.2.5   Hardcopy

The ESAOTE MRI System Administrator tools must be used to set the AE Title, port-number, host-name and capabilities (Printer Profile) for the for the remote Print SCPs. Multiple remote Print SCPs can be defined.

4.4.2   Parameters

A few parameters related to acquisition and general operation can be configured using the Service or the Administration Tool. The Table below only shows those configuration parameters relevant to DICOM communication. See the ESAOTE MRI System Service Manual for details on general configuration capabilities.

Table 52
CONFIGURATION PARAMETERS TABLE

Parameter	Configurable (Yes/No)	Default Value
General Parameters		
Max PDU Receive Size	No	28672 Bytes
Max PDU Send Size (larger PDUs will never be sent, even if the receiver supports a larger Max PDU Receive Size. If the receiver supports a smaller Max PDU Receive Size then the Max PDU Send Size will be reduced accordingly for the duration of the Association. Max PDU Receive Size information is exchanged during DICOM Association Negotiation in the Maximum Length Sub-Item of the A-ASSOCIATION-RQ and A-ASSOCIATE-AC)	No	28672 Bytes
Time-out waiting for a acceptance or rejection response to an Association Request (Application Level Timeout)	No	60 s
Time-out waiting for a response to an Association release request (Application Level Timeout)	No	60 s
Time-out waiting for completion of a TCP/IP connect request (Low-level timeout)	No	15 s [4]
Time-out awaiting a Response to a DIMSE Request (Low-Level Timeout)	Yes	60 s
Time-out for waiting for data between TCP/IP-packets (Low Level	No	60 s

---

[4] it was 60 s in the 9.0A releases.

Parameter	Configurable (Yes/No)	Default Value
Timeout)		
Storage Parameters		
Storage SCU time-out waiting for a response to a C-STORE-RQ	Yes	60 s
Number of times a failed send job may be retried	No	0 (Failed send jobs are not retried)
Delay between retrying failed send jobs	No	Not applicable
Maximum number of simultaneously initiated Associations by the Storage AE	No	1
Supported Transfer Syntaxes (separately configurable for each remote AE)	No	See Table 10, not separately configurable
Modality Worklist Parameters		
Modality Worklist SCU time-out waiting for the final response to a C-FIND-RQ	Yes	60 s
Maximum number of Worklist Items	No	Unlimited
Supported Transfer Syntaxes for Modality Worklist	No	See Table 28
Delay between automatic Worklist Updates	No	No automatic retry
Query Worklist for specific Scheduled Station AE Title	Yes	Local AE Title
Query Worklist for specific Modality Value	No	MR
Print Parameters		
Print SCU time-out waiting for a response to a N-CREATE-RQ	Yes	60 s
Print SCU time-out waiting for a response to a N-SET-RQ	Yes	60 s
Print SCU time-out waiting for a response to a N-ACTION-RQ	Yes	60 s
Supported Transfer Syntaxes (separately configurable for each remote printer)	No	See Table 36, not separately configurable
Number of times a failed print-job may be retried	No	0 (Failed send jobs are not retried)
Delay between retrying failed print-jobs	No	Not applicable
Printer correction LUT (separately configurable for each remote printer)	No	Not applied

5 MEDIA INTERCHANGE[5]

5.1   IMPLEMENTATION MODEL

5.1.1   Application Data Flow
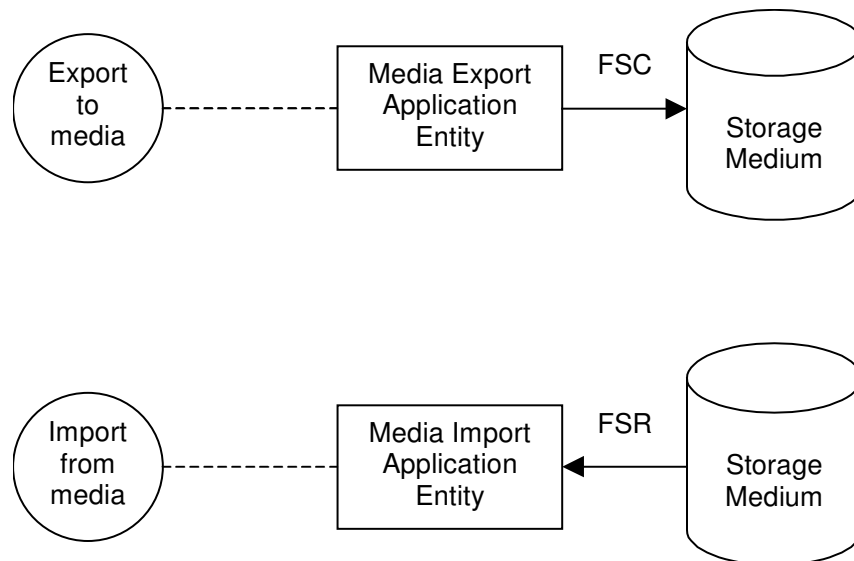
Figure 6
APPLICATION DATA FLOW DIAGRAM FOR MEDIA STORAGE

— The Media Export Application Entity exports images to a Storage medium, formatting it. It is associated
     with the local real-world activity "Export". "Export" is performed upon user request for
     selected patients, studies or series.

— The Media Import Application Entity imports MR images from a Storage medium. It is associated with the
     local real-world activity "Import". "Import" is performed upon user request.

5.1.2   Functional Definition of AEs

5.1.2.1   Functional Definition of Media Export Application Entity

Activation of the "Export" pop-up menu entry will pass the currently selected patients, studies or series to the
Media Export Application Entity. The SOP Instances associated with the selection will be collected into one
export job. The contents of each export job will be written to a single CD-R or DVD medium.

5.1.2.2   Functional Definition of Media Import Application Entity

Activation of the "Import" icon will read the inserted CD-ROM, allowing to review or to import in the local
database the MR Images found on it.

5.1.3   Sequencing of Real-World Activities

From the internal database menu the user can select one or more patients, studies or series. At least one
instance must exist and be selected before the Media Export Application Entity can be invoked, selecting the
"Export" item in the pop-up menu.

_____

[5] DVD is supported starting with the 9.4A software releases.

The operator should insert a new medium, otherwise a message will appear asking her to insert it. If the complete dataset cannot be stored on a single CD-R or DVD, it will be divided into two or more; after burning the CD-R or DVD with the first dataset, the user will then be asked to insert a new CD-R or DVD, etc., until finished.

A viewer will be automatically put into the media, if the "Viewer Lite" option is enabled (when present).

When using the Media Import Application Entity, the DICOMDIR will be used to access the instances referenced by it; anyway, it will also be possible to access the subfolders of the inserted medium to search the DICOM files in them, even if not referenced by the DICOMDIR.

5.1.4 File Meta Information Options

The implementation information written to the File Meta Header in each file can be found in Table 4.

5.2 AE SPECIFICATIONS

5.2.1 Media Export Application Entity Specification

The Media Export Application Entity provides standard conformance to the Media Storage Service Class. The Application Profiles and roles are listed below:

Table 53
APPLICATION PROFILES, ACTIVITIES AND ROLES FOR MEDIA EXPORT

Application Profiles Supported	Real World Activity	Role
STD-GEN-CD	Export to CD-R	FSC
STD-CTMR-CD	Export to CD-R	FSC
STD-CTMR-DVD	Export to DVD	FSC
STD-GEN-DVD-JPEG	Export to DVD	FSC

5.2.1.1 File Meta Information for the Application Entity

The Source Application Entity Title included in the File Meta Header corresponds to the Local Application Entity Title as described in Table 4.

5.2.1.2 Real-World Activities

5.2.1.2.1 Activity – Export to CD-R and DVD

The Media Export Application Entity acts as an FSC when requested to export SOP Instances from the local database to a CD-R or DVD medium.

From the internal database menu the user can select one or more patients, studies or series. At least one instance must exist and be selected before the Media Export Application Entity can be invoked, selecting the "Export" item in the pop-up menu.

Pressing "Export", a panel appears in which the user can select the destination. Please note that only the CD-R ("Recordable Compact Disc") and DVD devices allow to create DICOM compatible removable media according to the Media Application Profile(s) described in this section. Selecting something else, if present, can export the DICOM instances to non-standard archiving devices.

The operation above can be repeated many times, adding items to the list in the "Output" area; when all the wanted instances are added, the user can select the "Create CD" item in the pop-up menu of the "Output" area, and the CD-R or DVD will be burnt.

The operator should insert a new medium, otherwise a message will appear asking her to insert it. If the complete dataset cannot be stored on a single CD-R or DVD, it will be divided into two or more; after burning the CD-R or DVD with the first dataset, the user will then be asked to insert a new CD-R or DVD, etc., until finished.

The contents of the export job will be written together with a corresponding DICOMDIR to a single-session CD-R or DVD. Writing in multi-session mode is not supported. The user can cancel an export job in the job queue.

5.2.1.2.1.1.   Media Storage Application Profiles

The Media Export Application Entity supports the STD-GEN-CD, STD-CTMR-CD, STD-CTMR-DVD and STD-GEN-DVD-JPEG Application Profiles.

Options

The Media Export Application Entity supports the SOP Classes and Transfer Syntaxes listed in the Table below:

Table 54
IODS, SOP CLASSES AND TRANSFER SYNTAXES FOR MEDIA EXPORT

Information Object Definition	SOP Class UID	Transfer Syntax	Transfer Syntax UID
Media Storage Directory Storage	1.2.840.10008.1.3.10	Explicit VR Little Endian	1.2.840.10008.1.2.1
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Explicit VR Little Endian	1.2.840.10008.1.2.1

5.2.2   Media Import Application Entity Specification

The Media Import Application Entity provides standard conformance to the Media Storage Service Class. The Application Profiles and roles are listed below:

Table 55
APPLICATION PROFILES, ACTIVITIES AND ROLES FOR MEDIA IMPORT

Application Profiles Supported	Real World Activity	Role
STD-GEN-CD	Import from CD-R	FSR

5.2.2.1   File Meta Information for the Application Entity

Not applicable.

5.2.2.2   Real-World Activities

5.2.2.2.1   Activity – Import from CD-R

The Media Import Application Entity acts as an FSR when requested to review or to import SOP Instances from a CD-ROM medium to the local database.

After inserting a CD-ROM, in the "Device Management" area for the CD-ROM device the list of the patients will appear. The user, clicking on a patient, will see the list of the studies belonging to her; clicking on the studies will see the list of the series, and clicking on the series will see the list of the instances. The instances for which the SOP Instance UID is not MR Image Storage will be marked with a particular sign and the user will not be allowed to open or import them.

The user can select one or more patients, or one or more studies or one or more series or one or more images to import the MR instances present in them to the local database.

The user can select one patient, or one study, or one series, or one image to open the MR instances in the viewer.

5.2.2.2.1.1.   Media Storage Application Profiles

The Media Import Application Entity support the STD-GEN-CD Application Profile.

Options

The Media Import Application Entity supports the SOP Classes and Transfer Syntaxes listed in the Table below:

Table 56
IODS, SOP CLASSES AND TRANSFER SYNTAXES FOR MEDIA IMPORT

Information Object Definition	SOP Class UID	Transfer Syntax	Transfer Syntax UID
Media Storage Directory Storage	1.2.840.10008.1.3.10	Explicit VR Little Endian	1.2.840.10008.1.2.1
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Explicit VR Little Endian	1.2.840.10008.1.2.1

The DICOMDIR file created includes the Basic Directory IOD containing Directory Records at the Patient and the subsidiary Study and Series levels, appropriate to the SOP Classes in the corresponding File Set. All Type 1 and Type 2 attributes, plus some Type 3 attributes of the Basic Directory IOD are included in the DICOMDIR.

The following table describes the Type 3 attributes that are inserted in the Basic Directory IOD if presents in the image:

Table 57
DICOMDIR TYPE 3 ATTRIBUTES

Tag	Attribute
(0010,0030)	Patient's Birth Date
(0010,0040)	Patient Sex
(0008,0021)	Series date
(0008,0031)	Series time
(0008,103E)	Series description
(0008,0080)	Institution Name
(0008,0081)	Institution Address
(0008,1050)	Performing Physicians' Name
(0008,0008)	Image Type
(0008,0023)	Content date
(0008,0033)	Content time
(0008,1140)	Referenced Image Sequence
(0008,1150)	>Referenced SOP Class UID
(0008,1155)	>Referenced SOP Instance UID
(0020,0032)	Image Position (Patient)
(0020,0037)	Image Orientation (Patient)
(0020,0052)	Frame of Reference UID
(0028,2112)	Lossy Image Compression Ratio
(0028,0008)	Number of Frames

(0028,0010)	Rows
(0028,0011)	Columns
(0028,0030)	Pixel Spacing

AUGMENTED AND PRIVATE APPLICATION PROFILES

The ESAOTE MRI system does not support any augmented or private application profiles.

5.3   MEDIA CONFIGURATION

The Source Application Entity Title included in the File Meta Header corresponds to the Local Application Entity Title as described in Table 4.

6 SUPPORT OF CHARACTER SETS

All the ESAOTE MRI system DICOM applications support the

ISO_IR 100 (ISO 8859-1:1987 Latin Alphabet No. 1 supplementary set)

7 SECURITY

The ESAOTE MRI system does not support any specific security measures.

It is assumed that the ESAOTE MRI system is used within a secured environment. It is assumed that a secured environment includes at a minimum:

a. Firewall or router protections to ensure that only approved external hosts have network access to the ESAOTE MRI system.
b. Firewall or router protections to ensure that the ESAOTE MRI system only has network access to approved external hosts and services.
c. Any communication with external hosts and services outside the locally secured environment use appropriate secure network channels (e.g. such as a Virtual Private Network (VPN))

Other network security procedures such as automated intrusion detection may be appropriate in some environments. Additional security features may be established by the local security policy and are beyond the scope of this conformance statement.

8 ANNEXES

8.1   IOD CONTENTS

8.1.1   Created SOP Instances

Table 58 specifies the attributes of an MR Image transmitted by the ESAOTE MRI system storage application.

> NOTE: All dates and times are encoded in the local configured calendar and time. Date, Time and Time zone are configured using the Configuration Tool.

8.1.1.1   MR Image IOD

Table 58
IOD OF CREATED MR SOP INSTANCES

IE	Module	Reference	Presence of Module
Patient	Patient	Table 59	ALWAYS
Study	General Study	Table 60	ALWAYS
	Patient Study	Table 61	ALWAYS
Series	General Series	Table 62	ALWAYS
Frame of Reference	Frame of Reference	Table 63	ALWAYS
Equipment	General Equipment	Table 64	ALWAYS
Image	General Image	Table 65	ALWAYS
	Image Plane	Table 66	ALWAYS
	Image Pixel	Table 67	ALWAYS
	Contrast/bolus	Table 68	ANAP
	MR Image	Table 69	ALWAYS
	VOI LUT	Table 70	ALWAYS
	SOP Common	Table 71	ALWAYS
	Private Application	Table 72	ALWAYS

8.1.1.2   MR Image Modules

Table 59
PATIENT MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Patient's Name	(0010,0010)	PN	From Modality Worklist or user input. Values supplied via Modality Worklist will be entered as received. Values supplied via user input will contain all 5 components (some possibly empty).	ALWAYS	MWL/ USER

Patient ID	(0010,0020)	LO	From Modality Worklist or user input. Maximum 64 characters. If not provided, it will be generated in a unique way for the machine.	ALWAYS	MWL/ USER
Patient's Birth Date	(0010,0030)	DA	From Modality Worklist or user input[6].	VNAP	MWL/ USER
Patient's Sex	(0010,0040)	CS	From Modality Worklist or user input (*F*, *M* or *O*).	VNAP	MWL/ USER
Patient Comments	(0010,4000)	LT	Present only if received from Modality Worklist.	ANAP	MWL

Table 60
GENERAL STUDY MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Study Instance UID	(0020,000D)	UI	From Modality Worklist or generated by the device.	ALWAYS	MWL/ AUTO
Study Date	(0008,0020)	DA	<yyyymmdd>	ALWAYS	AUTO
Study Time	(0008,0030)	TM	<hhmmss>	ALWAYS	AUTO
Referring Physician's Name	(0008,0090)	PN	From Modality Worklist or user input.	VNAP	MWL/ USER
Study ID	(0020,0010)	SH	Requested Procedure ID from Worklist or generated in a unique way for the acquiring machine.	ALWAYS	MWL/ AUTO
Accession Number	(0008,0050)	SH	From Modality Worklist or user input.	VNAP	MWL/ USER
Study Description	(0008,1030)	LO	Comment text box in study list. Maximum 64 characters.	ANAP	USER
Referenced Study Sequence	(0008,1110)	SQ	From Modality Worklist.	ANAP	MWL
>Referenced SOP Class UID	(0008,1150)	UI	From Modality Worklist.	ANAP	MWL
>Referenced SOP Instance UID	(0008,1155)	UI	From Modality Worklist.	ANAP	MWL

Table 61
PATIENT STUDY MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Admitting Diagnoses Description	(0008,1080)	LO	From Modality Worklist or user input.	ANAP	MWL/ USER
Patient's Size	(0010,1020)	AS	From Modality Worklist.	ANAP	MWL
Patient's Weight	(0010,1030)	DS	From Modality Worklist.	ANAP	MWL
Occupation	(0010,2180)	SH	From Modality Worklist.	ANAP	MWL
Additional Patient History	(0010,21B0)	LT	From Modality Worklist or user input.	ANAP	MWL/ USER

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[6] The Patient's Birth Date input by the user is checked against incorrect values (future dates, wrong century, etc.): if not acceptable the date of yesterday is used instead. If the user does not fill the Patient's Birth Date, and the worklist is not used, a default date will be used anyway (the 1st of January of the current year).

Table 62
GENERAL SERIES MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Modality	(0008,0060)	CS	*MR.*	ALWAYS	AUTO
Series Instance UID	(0020,000E)	UI	Generated by device.	ALWAYS	AUTO
Series Number	(0020,0011)	IS	Generated by device.	ALWAYS	AUTO
Laterality	(0020,0060)	CS	From user input (*L* or *R*).	ALWAYS	USER
Series Date	(0008,0021)	DA	<yyyymmdd>	ALWAYS	AUTO
Series Time	(0008,0031)	TM	<hhmmss>	ALWAYS	AUTO
Protocol Name	(0018,1030)	LO	Name of the selected protocol. Not present for the SCOUT images.	ANAP	AUTO
Series Description	(0008,103E)	LO	According to the selected MR sequence.	ALWAYS	AUTO
Body Part Examined	(0018,0015)	CS	From the user input: *ELBOW*, *KNEE*, *ANKLE*, *HAND*, *FOOT*, *LEG*, *SHOULDER*, *HIP*, *ARM*, *CSPINE*, *SSPINE*, *TSPINE*[7], *LSPINE* (defined terms), *THIGH*, *WRIST*, *FOREARM*, *OTHER* (implementation-defined terms) [8].	ALWAYS	USER
Patient Position	(0018,5100)	CS	From user input.	ALWAYS	USER
Request Attributes Sequence	(0040,0275)	SQ	Present only if received from Modality Worklist.	ANAP	MWL
>Requested Procedure ID	(0040,1001)	SH	From Modality Worklist.	ANAP	MWL
>Scheduled Procedure Step ID	(0040,0009)	SH	From Modality Worklist.	ANAP	MWL
>Scheduled Procedure Step Description	(0040,0007)	LO	From Modality Worklist.	ANAP	MWL
>Scheduled Protocol Code Sequence	(0040,0008)	SQ	From Modality Worklist.	ANAP	MWL
Performed Procedure Step ID	(0040,0253)	SH	The same of the Study ID.	ALWAYS	AUTO
Performed Procedure Step Start Date	(0040,0244)	DA	The same of the Study Date.	ALWAYS	AUTO
Performed Procedure Step Start Time	(0040,0245)	TM	The same of the Study Time.	ALWAYS	AUTO
Performed Procedure Step Description	(0040,0254)	LO	The same of the Study Description.	ANAP	AUTO

Table 63
FRAME OF REFERENCE MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Frame of Reference UID	(0020,0052)	LO	A new value is generated each time a SCOUT is made.	ALWAYS	AUTO

[7] Not present since the release G-9.4A.

[8] See Table 76 for the Vet-MR software releases.

Position Reference Indicator	(0020,1040)	LO	Not applicable for our kind of systems.	EMPTY	AUTO

Table 64
GENERAL EQUIPMENT MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Manufacturer	(0008,0070)	LO	*ESAOTE.*	ALWAYS	AUTO
Institution Name	(0008,0080)	LO	From Service Configuration.	VNAP	CONFIG
Station Name	(0008,1010)	SH	From Service Configuration.	ALWAYS	CONFIG
Institutional Department Name	(0008,1040)	LO	The Department, from Service Configuration.	ALWAYS	CONFIG
Manufacturer's Model Name	(0008,1090)	LO	*C-scan* (C-scan and Artoscan-C), *E-Scan* (E-scan XQ and E-scan Opera)*, G-scan, S-scan* or *Vet-MR* (Vet-MR and Vet-MR Grande) .	ALWAYS	AUTO
Device Serial Number	(0018,1000)	LO	The System Code, from Service Configuration.	ALWAYS	CONFIG
Software Version(s)	(0018,1020)	LO	The official software version (VM=1).	ALWAYS	AUTO

Table 65
GENERAL IMAGE MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Instance Number	(0020,0013)	IS	A progressive number for the images acquired or generated by the machine. This attribute was named Image Number in earlier versions of the Standard.	ALWAYS	AUTO
Content Date	(0008,0023)	DA	<yyyymmdd>	ALWAYS	AUTO
Content Time	(0008,0033)	TM	<hhmmss>	ALWAYS	AUTO
Acquisition Date	(0008,0022)	DA	<yyyymmdd>	ALWAYS	AUTO
Acquisition Time	(0008,0032)	TM	<hhmmss>	ALWAYS	AUTO
Images in Acquisition	(0020,1002)	IS	Generated by device.	ALWAYS	AUTO
Referenced Image Sequence	(0008,1140)	SQ	If planned on other images, it contains the SOP Class - SOP Instance UIDs of these images: the three SCOUT images and eventually a fourth reference image.	ANAP	AUTO
> Referenced SOP Class UID	(0008,1150)	UI	*1.2.840.10008.5.1.4.1.1.4* (MR Image Storage SOP Class).	ALWAYS	AUTO
> Referenced SOP Instance UID	(0008,1155)	UI	Generated by device.	ALWAYS	AUTO
Source Image Sequence	(0008,2112)	SQ	If derived from other images, it contains the SOP Class - SOP Instance UIDs of these images.	ANAP	AUTO
> Referenced SOP Class UID	(0008, 1150)	UI	*1.2.840.10008.5.1.4.1.1.4* (MR Image Storage SOP Class).	ALWAYS	AUTO

> Referenced SOP Instance UID	(0008, 1155)	UI	Generated by device.	ALWAYS	AUTO
Lossy Image Compression	(0028,2110)	CS	*00.*	ALWAYS	AUTO

Table 66
IMAGE PLANE MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Pixel Spacing	(0028,0030)	DS	Generated by device.	ALWAYS	AUTO
Image Orientation (Patient)	(0020,0037)	DS	Generated by device.	ALWAYS	AUTO
Image Position (Patient)	(0020,0032)	DS	Generated by device.	ALWAYS	AUTO
Slice Thickness	(0018,0050)	DS	Generated by device.	ALWAYS	AUTO
Slice Location	(0020,1041)	DS	Generated by device.	ALWAYS	AUTO

Table 67
IMAGE PIXEL MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Rows	(0028,0010)	US	*256* for 256x256 images, *512* for 512x512 images.	ALWAYS	AUTO
Columns	(0028,0011)	US	*256* for 256x256 images, *512* for 512x512 images.	ALWAYS	AUTO
Bits Stored	(0028,0101)	US	*12.*	ALWAYS	AUTO
High Bit	(0028,0102)	US	*11.*	ALWAYS	AUTO
Pixel Representation	(0028,0103)	US	*0000H* (unsigned integer).	ALWAYS	AUTO
Pixel Data	(7FE0,0010)	OW	The Pixel Data itself does not contain any burned-in annotation.	ALWAYS	AUTO

Table 68
CONTRAST/BOLUS MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Contrast/Bolus Agent	(0018,0010)	LO	From user input.	VNAP	USER
Contrast/Bolus Route	(0018,1040)	LO	From user input.	ANAP	USER
Contrast/Bolus Volume	(0018,1041)	DS	From user input.	ANAP	USER
Contrast/Bolus Total Dose	(0018,1044)	DS	From user input.	ANAP	USER
Contrast Flow Rate	(0018,1046)	DS	From user input. VM=1.	ANAP	USER

Table 69
MR IMAGE MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Image Type	(0008,0008)	CS	*ORIGINAL\PRIMARY\DENSITY MAP, ORIGINAL\PRIMARY\T1 MAP, ORIGINAL\PRIMARY\T2MAP* according to the sequence; *DERIVED\SECONDARY\MPR* for images produced reformatting a 3D acquisition.	ALWAYS	AUTO
Samples per Pixel	(0028,0002)	US	*1.*	ALWAYS	AUTO
Photometric Interpretation	(0028,0004)	CS	*MONOCHROME2.*	ALWAYS	AUTO
Bits Allocated	(0028,0100)	US	*16.*	ALWAYS	AUTO
Scanning Sequence	(0018,0020)	CS	According to the sequence. VM=1.	ALWAYS	AUTO
Sequence Variant	(0018,0021)	CS	According to the sequence. VM=1.	ALWAYS	AUTO
Scan Options	(0018,0022)	CS	*PFF*, *PFP* (defined terms) and *NONE* (implementation-defined term). When present VM=1.	VNAP	AUTO
MR Acquisition Type	(0018,0023)	CS	According to the sequence.	ALWAYS	AUTO
Repetition Time	(0018,0080)	DS	According to the sequence.	ALWAYS	AUTO
Echo Time	(0018,0081)	DS	According to the sequence.	ALWAYS	AUTO
Echo Train Length	(0018,0091)	IS	*1.*	ALWAYS	AUTO
Receive Coil Name	(0018,1250)	SH	An integer number; for the relationship between the value in this attribute and the coil see 8.1.5.	ALWAYS	AUTO
Inversion Time	(0018,0082)	DS	According to the sequence.	ANAP	AUTO
Sequence Name	(0018,0024)	SH	According to the sequence.	ALWAYS	AUTO
Number of Averages	(0018,0083)	DS	According to the sequence.	ALWAYS	AUTO
Imaging Frequency	(0018,0084)	DS	According to the hardware characteristics.	ALWAYS	AUTO
Imaged Nucleus	(0018,0085)	SH	*1H.*	ALWAYS	AUTO
Echo Number(s)	(0018,0086)	IS	According to the sequence. VM=1.	ALWAYS	AUTO
Magnetic Field Strength	(0018,0087)	DS	0.25T for G-scan, S-scan and Vet-MR Grande, 0.18T for the other systems.	ALWAYS	AUTO
Spacing Between Slices	(0018,0088)	DS	According to the sequence, not present if the sequence is a Scout.	ANAP	AUTO
Acquisition Matrix	(0018,1310)	US	According to the sequence.	ALWAYS	AUTO
Phase Encoding Direction	(0018,1312)	CS	According to the sequence.	ALWAYS	AUTO
Flip Angle	(0018,1314)	DS	According to the sequence.	ALWAYS	AUTO
dB/dt	(0018,1318)	DS	Present only if above the threshold value.	ANAP	AUTO

Table 70
VOI LUT MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Window Center	(0028,1050)	DS	After acquiring the images, this attribute will be calculated in an automatic way. After manually changing the window center, it is possible to modify the value of this attribute in a permanent way by pressing the "Save Series" button in the "File" submenu.	ALWAYS	AUTO
Window Width	(0028,1051)	DS	After acquiring the images, this attribute will be calculated in an automatic way. After manually changing the window width, it is possible to modify the value of this attribute in a permanent way by pressing the "Save Series" button in the "File" submenu.	ALWAYS	AUTO

Table 71
SOP COMMON MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Specific Character Set	(0008,0005)	CS	*ISO_IR 100.*	ALWAYS	AUTO
SOP Class UID	(0008,0016)	UI	*1.2.840.10008.5.1.4.1.1.4* (MR Image Storage SOP Class).	ALWAYS	AUTO
SOP Instance UID	(0008,0018)	UI	Generated by device.	ALWAYS	AUTO

Table 72
PRIVATE APPLICATION MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Private Creator	(0011,0010)	LO	*V1.*	ALWAYS	AUTO
User Data	(0011,1001)	OB	Variable length: contains information about the image acquisition.	ALWAYS	AUTO
Normalization Coefficient	(0011,1002)	DS	Normalization coefficient for the grey levels in the image (default: 3.5). Unit of measurement: none.	ALWAYS	AUTO
Receiving Gain	(0011,1003)	DS	Receiving gain in order to obtain the necessary dynamic range. Unit of measurement: arbitrary units.	ALWAYS	AUTO
Mean Image Noise	(0011,1004)	DS	Mean value of the noise in the image. Unit of measurement: grey level values.	ALWAYS	AUTO

8.1.2   Used Fields in received IOD by application

The ESAOTE MRI system storage application receives SOP Instances of the MR Image Storage SOP Class, both by Storage SCP or importing them from removable media. The attributes that are also present in the instances produced by ESAOTE are used, in the same way. The usage of attributes received via Modality Worklist SOP Class is described in section 4.2.4.4.1.3.

8.1.3 Attribute mapping

The relationships between attributes received via Modality Worklist, stored in acquired images, are summarized in Table 73. The format and conventions used in it are the same as the corresponding table in DICOM Part 4, Annex M.6 [DICOM].

Table 73
ATTRIBUTE MAPPING BETWEEN MODALITY WORKLIST AND IMAGES

Modality Worklist	Image IOD
Patient Name	Patient Name
Patient ID	Patient ID
Patient's Birth Date	Patient's Birth Date
Patient's Sex	Patient's Sex
Patient's Size	Patient's Size
Patient's Weight	Patient's Weight
Referring Physician's Name	Referring Physician's Name
Occupation	Occupation
Patient Comments	Patient Comments
Additional Patient History	Additional Patient History
Study Instance UID	Study Instance UID
Referenced Study Sequence	Referenced Study Sequence
Accession Number	Accession Number
	Request Attributes Sequence
Requested Procedure ID	>Requested Procedure ID
Requested Procedure Description	----
Scheduled Procedure Step ID	>Scheduled Procedure Step ID
Scheduled Procedure Step Description	>Scheduled Procedure Step Description
Scheduled Protocol Code Sequence	>Scheduled Protocol Code Sequence
----	Study ID
Study ID [9]	Performed Procedure Step ID
Study Date [9]	Performed Procedure Step Start Date
Study Time [9]	Performed Procedure Step Start Time
Study Description [10]	Performed Procedure Step Description
Requested Procedure Code Sequence	----
----	Protocol Name

8.1.4 Coerced/Modified Fields

The Modality Worklist AE will truncate attribute values received in the response to a Modality Worklist Query if the value length is longer than the maximum length permitted by the attribute's VR.

8.1.5 Meaning of the Receive Coil Name (0018,1250)

The attribute Receive Coil Name (0018,1250) contains an integer number; the relationship between its contents and the effective receive coil, according to the model, is given in the following table.

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[9] These attributes are not received from the worklist, but automatically generated by the machine.

[10] This attribute is not received from the worklist, but can be filled by the user.

Table 74
MEANING OF THE RECEIVE COIL NAME CONTENTS

Receive Coil Name (0018,1250)	C-scan / Artoscan-C	E-scan XQ / E-scan Opera	G-scan/S-scan	Vet-MR	Vet-MR Grande
0	Coil 1	Coil 1	Coil 1	Coil 1	Coil 1
1	Coil 2	Coil 2	Coil 2	Coil 2	Coil 2
2	Coil 3	Coil 3	Coil 3	Coil 3	Coil 3
3	Coil 4	Coil 4	Coil 4	Coil 4	Coil 4
4	Coil 5	Coil 5	= = =	Coil 5	= = =
5	Coil 6	Coil 6	Coil 6	Coil 6	Coil 6
6	= = =	Coil 7	Coil 7	Coil 7	Coil 7
7	= = =	= = =	Coil 8 (high position)	= = =	= = =[11]
8	= = =	= = =	Coil 8 (low position)	= = =	= = =[12]
9	= = =	= = =	Coil 9	= = =	= = =[13]
10	= = =	= = =	= = =[14]	= = =	= = =[14]
11	= = =	= = =	= = =[15]	= = =	= = =[15]
12	= = =	= = =	Coil 10 (high position)[16]	= = =	Coil 10 (high position)[16]
13	= = =	= = =	Coil 10 (low position)[17]	= = =	Coil 10 (low position)[17]
14	= = =	= = =	Coil 11[18]	Coil 11[18]	Coil 11[19]
15	= = =	= = =	Coil 12[18]	Coil 12[18]	Coil 12[20]
16	= = =	= = =	= = =	= = =[21]	= = =

8.2   DATA DICTIONARY OF PRIVATE ATTRIBUTES

The Private Attributes added to created SOP Instances are listed in the Table below. The ESAOTE MRI system reserves blocks of private attributes in group 0011. Further details on usage of these private attributes are contained in Section 8.1.

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[11] It was "Coil 8 (high position)" till the release VG-9.2A.

[12] It was "Coil 8 (high low)" till the release VG-9.2A.

[13] It was "Coil 9" till the release VG-9.2A.

[14] It was "Coil 10 (high position)" till the releases G-9.4A and VG-9.2A.

[15] It was "Coil 10 (low position)" till the releases G-9.4A and VG-9.2A.

[16] It was "Coil 11 (high position)" till the releases G-9.4A and VG-9.2A.

[17] It was "Coil 11 (low position)" till the releases G-9.4A and VG-9.2A.

[18] Present since the releases G-9.5A and V-9.5A.

[19] It was "Coil 12" till the release VG-9.2A.

[20] It was "Coil 13" till the release VG-9.2A.

[21] It was "Coil 14" till the release V-9.2A.

Table 75
DATA DICTIONARY OF PRIVATE ATTRIBUTES

Tag	Attribute Name	VR	VM
(0011,0010)	Private Creator	LO	1
(0011,1001)	User Data	OB	1
(0011,1002)	Normalization Coefficient	DS	1
(0011,1003)	Receiving Gain	DS	1-n[22]
(0011,1004)	Mean Image Noise	DS	1
(0011,1005)	Patient Vet Name (only used for Vet-MR and Vet-MR Grande systems)	LT	1
(0011,1006)	Patient Vet Species (only used for Vet-MR and Vet-MR Grande systems)	LT	1
(0011,1007)	Patient Vet Breed (only used for Vet-MR and Vet-MR Grande systems)	LT	1

8.3   CODED TERMINOLOGY AND TEMPLATES

The ESAOTE MRI systems only partially support coded terminology or templates. The attributes Requested Procedure Code Sequence (0032,1064) and Scheduled Protocol Code Sequence (0040,0008) are requested by the Worklist AE, and will be mapped to Image IOD attributes as described in Section 8.1, but the User interface will visualize them using the content of the Code Value (0008,0100), Coding Scheme Designator (0008,0102), Coding Scheme Version (0008,0103) and Code Meaning (0008,0104) attributes.

8.4   GRAYSCALE IMAGE CONSISTENCY

The ESAOTE MRI do not support the Grayscale Standard Display Function (GSDF).

8.5   STANDARD EXTENSDED / SPECIALIZED / PRIVATE SOP CLASSES

No Specialized or Private SOP Classes are supported.

8.5.1   MR Image Storage SOP Class

The MR Image Storage SOP Class is extended to create a Standard Extended SOP Class by addition of standard and private attributes to the created SOP Instances as documented in section 8.1.

8.6   PRIVATE TRANSFER SYNTAXES

No Private Transfer Syntaxes are supported.

8.7   VET-MR AND VET-MR GRANDE IMAGES

The DICOM standard does not contain any specific veterinary attribute or defined term, so the following paragraphs show the differences in the meaning and contents of the DICOM attributes between the veterinary images produced by the Vet-MR, the Vet-MR Grande and those produced by the other software releases.

For the attributes that are not described in this Annex there is no difference between Vet-MR, Vet-MR Grande and the other software releases.

8.7.1   PATIENT MODULE

The Patient's Name (0010,0010) contains the name of the owner of the animal.

The data about the name, the species and the breed of the animal are put in the User Data (0011,1001) private attribute, in a proprietary format.

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[22] It was VM=1 till the releases 9.4A.

8.7.2   GENERAL SERIES MODULE

The following table shows the values that can be put in the field "Body Part Examined" (0018,0015) for the Vet-MR software releases.

Table 76
GENERAL SERIES MODULE OF CREATED MR SOP INSTANCES
SPECIALIZATION FOR VET-MR AND VET-MR GRANDE

Attribute Name	Tag	VR	Value	Presence of Value	Source
Body Part Examined	(0018,0015)	CS	From the Patient Registration: *ELBOW*, *SHOULDER*, *HIP* (defined terms), *NEUROCRANIUM*, *SPLANCHNOCRANIUM*, *CERVICAL*, *CERVICO_THORACIC*, *LUMBO_SACRAL*, *THORACO_LUMBAR*, *STIFLE*, *CARPUS*, *PAW_A*, *PAW_P*, *HOCK*, FETLOCK_A, FETLOCK_P, PASTERN_A, PASTERN_P, HOOF_P, HOOF_A and *OTHER* (implementation-defined terms)[23]. Some of these values are not available for all the species of animals.	ALWAYS	USER

8.7.3   PRIVATE APPLICATION MODULE

The following table shows the values that added to the Private Application Module (Table 72) for the Vet-MR and Vet-MR Grande software releases[24]. Please note that the Private Creator is the same as in that table, and these attributes are present only in the Vet-MR and Vet-MR Grande systems.

Table 77
PRIVATE APPLICATION MODULE OF CREATED MR SOP INSTANCES
SPECIALIZATION FOR VET-MR

Attribute Name	Tag	VR	Value	Presence of Value	Source
Patient Vet Name	(0011,1005)	LT	From the Patient Registration: name of the animal. Maximum 64 characters.	VNAP	USER
Patient Vet Species	(0011,1006)	LT	From the Patient Registration: species of the animal, can be selected among *DOG, CAT, HORSE*[25] or *OTHER* (implementation-defined terms).	ALWAYS	USER
Patient Vet Breed	(0011,1007)	LT	From the Patient Registration: breed of the animal. Maximum 64 characters.	VNAP	USER

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[23] PASTERN_A and PASTERN_P present since the release V-9.1A; FETLOCK_A and FETLOCK_P present since the releases V-9.2A and VG-9.2A; HOOF_A and HOOF_P present since the releases V-9.4A and VG-9.4A

[24] Not present in the release V-9.0A.

[25] Present since the releases V-9.2A and VG-9.2A.