



**G-scan
S-scan
Vet-MR Grande
G-scan Vet
O-scan
G-scan Brio
O-scan Equine
G-scan equine
Magnifico Open
Magnifico MSK
Magnifico Vet**

MRI Systems

DICOM Conformance Statement

Revision 3.10

Date 25 SEP 2021

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1 CONFORMANCE STATEMENT OVERVIEW

The G-scan, S-scan, Vet-MR Grande, G-scan Vet, G-scan Brio, O-scan, O-scan Equine, G-scan equine, Magnifico Open, Magnifico MSK and Magnifico Vet are MRI scanners made by ESAOTE S.p.A.; their software is based upon the Windows Vista™ Ultimate Operating System (till the software release 3.0A E-MRI Brio excluded), upon Windows 7™ Ultimate Operating System (since the software release 3.0A E-MRI Brio included, till the software release MRI EVO'20.0 excluded) or upon Windows 10™ IoT 2019 LTSC Operating System (since the software MRI EVO'20.0 release included). This DICOM® Conformance Statement (DCS) specifies the conformance to the DICOM standard ¹ for these ESAOTE 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 and produced GSPS objects to a network storage device, CD-R, DVD or USB, print to a networked hardcopy device and receive MR images from the network.

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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
Grayscale Softcopy Presentation State ³	Yes	Yes (*)
Workflow Management		
Modality Worklist	Yes	No
Storage Commitment Push Model	Yes	No
Modality Performed Procedure Step	Yes	No
Print Management		
Basic Grayscale Print Management	Yes	No
Query/Retrieve ⁴		
Study Root Information Model FIND	Yes (**)	No
Study Root Information Model MOVE	Yes	No

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

² O-scan is supported since the software release 1.1B E-MRI Vista. G-scan Brio is supported since the software release 2.0A E-MRI Brio. O-scan Equine is supported since the software release 4.0 E-MRI Brio. G-scan equine is supported since the software release MRI EVO'18. Magnifico Open, Magnifico MSK and Magnifico Vet are supported since the software release MRI EVO'21.

³ Since the software release 4.0A E-MRI Brio.

⁴ Since the software release MRI EVO'15 Update 1.

- (*) Presentation State objects produced by ESAOTE MRI systems only.
- (**) Only Studies containing MRI series.

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
USB connected removable device ⁵		
General Purpose USB Media Interchange with JPEG (STD-GEN-USB-JPEG)	Yes	Yes

⁵ Since the software release 1.3A E-MRI Brio.

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3 INTRODUCTION

3.1 REVISION HISTORY

Table 3
REVISION HISTORY

Document Version	Date of Issue	Author	Description	SW Releases
3.0	Aug. 28 th , 2009	Marco Spaggiari, Luigi Pampana-Biancheri	From version 2.4, adapted for E-MRI Vista sw releases only.	1.1A E-MRI Vista
3.1	Nov. 06 th , 2009	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Revision of the table 4. - Renamed C-ECHO-SCP to Verification and added Verification SCU to paragraph 4.2.3. - Revision of the tables 93, 98 and 103. - Revision of figure 1. - Other minor changes. 	1.1B E-MRI Vista
3.2	Jun. 09 th , 2011	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Revision of the tables 2 and 98. - Added USB Storage. - Other minor changes. 	1.2A E-MRI Brio 1.2B E-MRI Brio 1.3A E-MRI Brio
3.3	May 15 th , 2013	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Revision of the tables 93, 98 and 103. - Other minor changes. 	1.3B E-MRI Brio 1.3C E-MRI Brio 2.0A E-MRI Brio 2.1A E-MRI Brio 2.1B E-MRI Brio 3.0A E-MRI Brio 3.1A E-MRI Brio
3.4	Mar 26 th , 2015	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Added Grayscale Softcopy Presentation State. - Added new system O-scan Equine. - Other minor changes. 	4.0A E-MRI Brio 4.1A E-MRI Brio
3.5	Sept 29 th , 2015	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Added Query/Retrieve. - Added Q/R-SCU to paragraph 4.1. - Modified Storage-SCP in paragraph 4.1. - Added paragraphs 4.2.2 and 4.4.1.2.2. - Modified paragraph 4.2.3. - Revision of the tables 51, 56, 80 and 81. - Revision of figure 1. - Other minor changes. 	MRI EVO'15 Update 1 (4.20.00 and 4.11.00 sw versions)
3.6	Mar 27 th , 2017	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Revision of the tables 90, 100 and 113 - Other minor changes. 	MRI EVO'16.0 (5.00.00, 4.13.00 and 4.12.00 sw versions), MRI EVO'16.1 (5.01.00, 4.15.00 and 4.14.00 sw

				versions), MRI EVO'16.2 (5.01.01, 5.02.00 and 4.14.01 sw versions), MRI EVO'17.0 (6.00.00, 5.03.00 and 4.16.00 sw versions)
3.7	Nov 29 th , 2019	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Revision of the tables 4, 91, 95 and 100. - Other minor changes. - Added new system G-scan equine. - Modified paragraphs 5.2.1.1 and 5.3 	MRI EVO'18.0 (7.0x.xx sw versions)
3.8	May 13 th , 2020	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Revision of the table 4. - Modified chapter 1. - Other minor changes. 	MRI EVO'20.0 (8.0x.xx sw versions)
3.9	Apr 09 th , 2021	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Revision of the tables 4, 91 and 100. - Added new system Magnifico. - Other minor changes. 	MRI EVO'21.0 (9.00.01 sw version)
3.10	Sep 25 th , 2021	Marco Spaggiari, Luigi Pampana-Biancheri	<ul style="list-style-type: none"> - Added new systems Magnifico (Open, MSK and Vet). - Added supported character sets (chapter 6). - Added security measures (chapter 7). - Revision of the tables 4, 24, 25, 51, 52, 56, 60, 93, 94, 102, 114 and 115. - Modified chapters 1, 6 and 7. - Other minor changes. 	MRI EVO'21.0 (9.01.01 sw version)

This document applies to all the software releases of the ESAOTE MRI systems, starting with the 1.1A E-MRI Vista 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 this document any specified software release is to be interpreted as an E-MRI Vista software release.

In case of differences in the behavior of the same software release for the different systems, the following identifiers will be used: *G-m.np* for the G-scan software releases, *S-m.np* for the S-scan software releases, *VG-m.np* for the Vet-MR Grande software releases, *GV-m.np* for the G-scan Vet software releases, *O-m.np* for the O-scan software releases, *OE-m.np* for the O-scan Equine software releases and *M-m.np* for Magnifico (for example, G-1.1A means G-scan software release 1.1A E-MRI Vista).

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

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3.2 AUDIENCE

This document is written for the people that need to understand how the ESAOTE MRI systems will integrate into their healthcare facility. This includes both those responsible for overall imaging network policy and architecture, as well as integrators who need to have a detailed understanding of the DICOM features of the ESAOTE MRI systems. This document contains some basic DICOM definitions so that any reader may understand how these products implement DICOM features. However, integrators are expected to fully understand all the DICOM terminology, how the tables in this document relate to the product's functionality, and how that functionality integrates with other devices that support compatible DICOM features.

3.3 REMARKS

The scope of this DICOM Conformance Statement is to facilitate integration between the ESAOTE MRI systems and other DICOM products. The Conformance Statement should be read and understood in conjunction with the DICOM Standard. DICOM by itself does not guarantee interoperability. The Conformance Statement does, however, facilitate a first-level comparison for interoperability between different applications supporting compatible DICOM functionality.

This Conformance Statement is not supposed to replace validation with other DICOM equipment to ensure proper exchange of intended information. In fact, the user should be aware of the following important issues:

- The comparison of different Conformance Statements is just the first step towards assessing interconnectivity and interoperability between the product and other DICOM conformant equipment.
- Test procedures should be defined and executed to validate the required level of interoperability with specific compatible DICOM equipment, as established by the healthcare facility.
- The ESAOTE MRI systems have participated in an industry-wide testing program sponsored by Integrating the Healthcare Enterprise (IHE). The IHE Integration Statement for the ESAOTE MRI systems, together with the IHE Technical Framework, may facilitate the process of validation testing. See <http://www.esaote.com/dicom.htm>.
- 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.

The DICOM functionalities given by the ESAOTE MRI systems are implemented by means of the DCMLab 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.

Some of the ESAOTE MRI systems are intended for veterinary usage: the DICOM veterinary attributes are not yet implemented, so the DICOM attributes of the veterinary images produced by the Vet-MR can have a meaning that could not exactly match their DICOM definition. See section 8.7 for further details.

3.4 TERMS AND DEFINITIONS

Informal definitions are provided for the following terms used in this Conformance Statement. The DICOM Standard is the authoritative source for formal definitions of these terms.

Abstract Syntax – the information agreed to be exchanged between applications, generally equivalent to a Service/Object Pair (SOP) Class. Examples : Verification SOP Class, Modality Worklist Information Model Find SOP Class, Computed Radiography Image Storage SOP Class.

Application Entity (AE) – an end point of a DICOM information exchange, including the DICOM network or media interface software; i.e., the software that sends or receives DICOM information objects or messages. A single device may have multiple Application Entities.

Application Entity Title – the externally known name of an *Application Entity*, used to identify a DICOM application to other DICOM applications on the network.

Application Context – the specification of the type of communication used between *Application Entities*. Example: DICOM network protocol.

Association – a network communication channel set up between *Application Entities*.

Attribute – a unit of information in an object definition; a data element identified by a *tag*. The information may be a complex data structure (Sequence), itself composed of lower level data elements. Examples: Patient ID (0010,0020), Accession Number (0008,0050), Photometric Interpretation (0028,0004), Procedure Code Sequence (0008,1032).

Information Object Definition (IOD) – the specified set of *Attributes* that comprise a type of data object; does not represent a specific instance of the data object, but rather a class of similar data objects that have the same properties. The *Attributes* may be specified as Mandatory (Type 1), Required but possibly unknown (Type 2), or Optional (Type 3), and there may be conditions associated with the use of an Attribute (Types 1C and 2C). Examples: MR Image IOD, CT Image IOD, Print Job IOD.

Joint Photographic Experts Group (JPEG) – a set of standardized image compression techniques, available for use by DICOM applications.

Media Application Profile – the specification of DICOM information objects and encoding exchanged on removable media (e.g., CDs)

Module – a set of *Attributes* within an *Information Object Definition* that are logically related to each other. Example: Patient Module includes Patient Name, Patient ID, Patient Birth Date, and Patient Sex.

Negotiation – first phase of Association establishment that allows *Application Entities* to agree on the types of data to be exchanged and how that data will be encoded.

Presentation Context – the set of DICOM network services used over an *Association*, as negotiated between *Application Entities*; includes *Abstract Syntaxes* and *Transfer Syntaxes*.

Protocol Data Unit (PDU) – a packet (piece) of a DICOM message sent across the network. Devices must specify the maximum size packet they can receive for DICOM messages.

Security Profile – a set of mechanisms, such as encryption, user authentication, or digital signatures, used by an *Application Entity* to ensure confidentiality, integrity, and/or availability of exchanged DICOM data

Service Class Provider (SCP) – role of an Application Entity that provides a DICOM network service; typically, a server that performs operations requested by another *Application Entity* (*Service Class User*). Examples: Picture Archiving and Communication System (image storage SCP, and image query/retrieve SCP), Radiology Information System (modality worklist SCP).

Service Class User (SCU) – role of an *Application Entity* that uses a DICOM network service; typically, a client. Examples: imaging modality (image storage SCU, and modality worklist SCU), imaging workstation (image query/retrieve SCU)

Service/Object Pair (SOP) Class – the specification of the network or media transfer (service) of a particular type of data (object); the fundamental unit of DICOM interoperability specification. Examples: Ultrasound Image Storage Service, Basic Grayscale Print Management.

Service/Object Pair (SOP) Instance – an information object; a specific occurrence of information exchanged in a *SOP Class*. Examples: a specific x-ray image.

Tag – a 32-bit identifier for a data element, represented as a pair of four digit hexadecimal numbers, the “group” and the “element”. If the “group” number is odd, the tag is for a private (manufacturer-specific) data element. Examples: (0010,0020) [Patient ID], (07FE,0010) [Pixel Data], (0019,0210) [private data element]

Transfer Syntax – the encoding used for exchange of DICOM information objects and messages.

Examples: *JPEG* compressed (images), little endian explicit value representation.

Unique Identifier (UID) – a globally unique “dotted decimal” string that identifies a specific object or a class of objects; an ISO-8824 Object Identifier. Examples: Study Instance UID, SOP Class UID, SOP Instance UID.

Value Representation (VR) – the format type of an individual DICOM data element, such as text, an integer, a person’s name, or a code. DICOM information objects can be transmitted with either explicit identification of the type of each data element (Explicit VR), or without explicit identification (Implicit VR); with Implicit VR, the receiving application must use a DICOM data dictionary to look up the format of each data element.

3.5 BASICS OF DICOM COMMUNICATION

This section describes terminology used in this Conformance Statement for the non-specialist. The key terms used in the Conformance Statement are highlighted in *italics* below. This section is not a substitute for training about DICOM, and it makes many simplifications about the meanings of DICOM terms.

Two *Application Entities* (devices) that want to communicate with each other over a network using DICOM protocol must first agree on several things during an initial network “handshake”. One of the two devices must initiate an *Association* (a connection to the other device), and ask if specific services, information, and encoding can be supported by the other device (*Negotiation*).

DICOM specifies a number of network services and types of information objects, each of which is called an *Abstract Syntax* for the Negotiation. DICOM also specifies a variety of methods for encoding data, denoted *Transfer Syntaxes*. The Negotiation allows the initiating Application Entity to propose combinations of Abstract Syntax and Transfer Syntax to be used on the Association; these combinations are called *Presentation Contexts*. The receiving Application Entity accepts the Presentation Contexts it supports.

For each Presentation Context, the Association Negotiation also allows the devices to agree on *Roles* – which one is the *Service Class User* (SCU - client) and which is the *Service Class Provider* (SCP - server). Normally the device initiating the connection is the SCU, i.e., the client system calls the server, but not always.

The Association Negotiation finally enables exchange of maximum network packet (*PDU*) size, security information, and network service options (called *Extended Negotiation* information).

The Application Entities, having negotiated the Association parameters, may now commence exchanging data. Common data exchanges include queries for worklists and lists of stored images, transfer of image objects and analyses (structured reports), and sending images to film printers. Each exchangeable unit of data is formatted by the sender in accordance with the appropriate *Information Object Definition*, and sent using the negotiated Transfer Syntax. There is a Default Transfer Syntax that all systems must accept, but it may not be the most efficient for some use cases. Each transfer is explicitly acknowledged by the receiver with a *Response Status* indicating success, failure, or that query or retrieve operations are still in process.

Two Application Entities may also communicate with each other by exchanging media (such as a CD-R). Since there is no Association Negotiation possible, they both use a *Media Application Profile* that specifies “pre-negotiated” exchange media format, Abstract Syntax, and Transfer Syntax.

3.6 ABBREVIATIONS

Abbreviations are as follows:

AE	Application Entity
AET	Application Entity Title
CAD	Computer Aided Detection
CDA	Clinical Document Architecture
CD-R	Compact Disk Recordable
CSE	Customer Service Engineer
CR	Computed Radiography

CT	Computed Tomography
DHCP	Dynamic Host Configuration Protocol
DICOM	Digital Imaging and Communications in Medicine
DIT	Directory Information Tree (LDAP)
DN	Distinguished Name (LDAP)
DNS	Domain Name System
DX	Digital X-ray
FSC	File-Set Creator
FSU	File-Set Updater
FSR	File-Set Reader
GSDF	Grayscale Standard Display Function
GSPS	Grayscale Softcopy Presentation State
HIS	Hospital Information System
HL7	Health Level 7 Standard
IHE	Integrating the Healthcare Enterprise
IOD	Information Object Definition
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISO	International Organization for Standards
IO	Intra-oral X-ray
JPEG	Joint Photographic Experts Group
LDAP	Lightweight Directory Access Protocol
LDIF	LDAP Data Interchange Format
LUT	Look-up Table
MAR	Medication Administration Record
MPEG	Moving Picture Experts Group
MG	Mammography (X-ray)
MPPS	Modality Performed Procedure Step
MR	Magnetic Resonance Imaging
MSPS	Modality Scheduled Procedure Step
MTU	Maximum Transmission Unit (IP)
MWL	Modality Worklist
NM	Nuclear Medicine
NTP	Network Time Protocol
O	Optional (Key Attribute)
OP	Ophthalmic Photography
OSI	Open Systems Interconnection
PACS	Picture Archiving and Communication System
PET	Positron Emission Tomography
PDU	Protocol Data Unit
R	Required (Key Attribute)

RDN	Relative Distinguished Name (LDAP)
RF	Radiofluoroscopia
RIS	Radiology Information System.
RT	Radiotherapy
SC	Secondary Capture
SCP	Service Class Provider
SCU	Service Class User
SOP	Service-Object Pair
SPS	Scheduled Procedure Step
SR	Structured Reporting
TCP/IP	Transmission Control Protocol / Internet Protocol
U	Unique (Key Attribute)
UL	Upper Layer
US	Ultrasound
VL	Visible Light
VR	Value Representation
XA	X-ray Angiography

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 are the following:

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

3.7 REFERENCES

NEMA PS3 Digital Imaging and Communications in Medicine (DICOM) Standard, available free at <http://medical.nema.org/>

3.8 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	DCMLab SW Release	Implementation Class UID	Implementation Version Name
1.1A E-MRI Vista	2.7.2.2	1.3.76.2.1.1.4	EOB_MRI_VIS_11A
1.1B E-MRI Vista	2.7.2.2	1.3.76.2.1.1.4	EOB_MRI_VIS_11B
1.2A E-MRI Brio	2.7.2.2	1.3.76.2.1.1.4	EOB_MRI_VIS_12A
1.2B E-MRI Brio	2.7.2.2	1.3.76.2.1.1.4	EOB_MRI_VIS_12B
1.3A E-MRI Brio	2.9	1.3.76.2.1.1.4	EOB_MRI_VIS_13A
1.3B E-MRI Brio	2.9	1.3.76.2.1.1.4	EOB_MRI_VIS_13B
1.3C E-MRI Brio	2.9	1.3.76.2.1.1.4	EOB_MRI_VIS_13C
2.0A E-MRI Brio	3.1	1.3.76.2.1.1.4	2.0A_E-MRI_Brio
2.1A E-MRI Brio	3.1	1.3.76.2.1.1.4	2.1A_E-MRI_Brio
2.1B E-MRI Brio	3.1	1.3.76.2.1.1.4	2.1B_E-MRI_Brio
3.0A E-MRI Brio	3.2.6	1.3.76.2.1.1.4	3.0A_E-MRI_Brio
3.1A E-MRI Brio	3.2.6	1.3.76.2.1.1.4	3.1A_E-MRI_Brio
4.0A E-MRI Brio	3.2.6	1.3.76.2.1.1.4	4.0A_E-MRI_Brio
4.1A E-MRI Brio	3.2.6	1.3.76.2.1.1.4	4.1A_E-MRI_Brio
MRI EVO'15 Update 1	3.2.6	1.3.76.2.1.1.4	REL_F040201
MRI EVO'16.0	3.3.7	1.3.76.2.1.1.4	REL_F050001
MRI EVO'16.1	3.3.7	1.3.76.2.1.1.4	REL_F050101
MRI EVO'16.2	3.3.7	1.3.76.2.1.1.4	REL_F050102
MRI EVO'17.0	3.4.3.0	1.3.76.2.1.1.4	REL_F060001
MRI EVO'18.0	3.4.3.0	1.3.76.2.1.1.4	REL_F070xxx
MRI EVO'20.0	3.4.3.0	1.3.76.2.1.1.4	REL_F080xxx
MRI EVO'21.0	3.4.8.4	1.3.76.2.1.1.4	REL_F090xxx

4 NETWORKING

4.1 IMPLEMENTATION MODEL

4.1.1 Application Data Flow

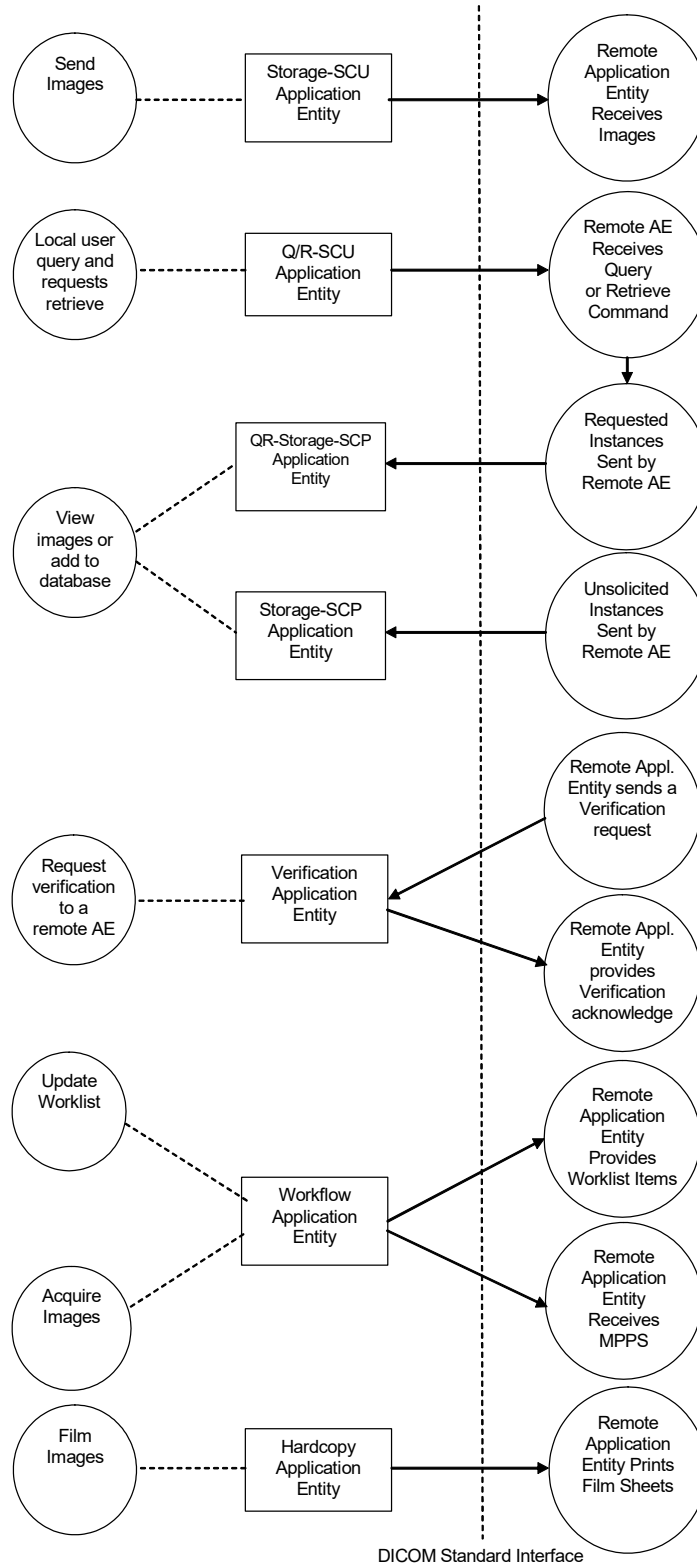


Figure 1
APPLICATION DATA FLOW DIAGRAM

- The Storage-SCU Application Entity sends images and produced GSPS objects to a remote Storage 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. If the remote Storage AE server is configured to be associated with a Storage Commitment server, the Storage-SCU AE will also request Storage Commitment for the sent images, and if a commitment is successfully obtained, will record this information in the local database.
- The Query/Retrieve-SCU Application Entity can query a DICOM Query/Retrieve SCP Application over the network, and then retrieve the instances to the local archive, from which they can be seen ⁶.
- The Storage-SCP Application Entity receives over the network from a remote AE the unsolicited images, and GSPS objects produced by ESAOTE MRI systems, from a remote AE. The received objects are put in a temporary storage area, from where they can be reviewed, deleted, or moved to the local database;
- The QR-Storage-SCP Application Entity receives over the network from a remote AE the instances requested using the Q/R-SCU Application Entity. The received objects are put in a temporary storage area, from where they are automatically moved to the local database ⁶.
- The Verification Application Entity responds to verification requests from a remote AE, and can send verification requests to any configured remote AE ⁷.
- The Workflow Application Entity receives Worklist information from a remote AE (worklist server) and sends MPPS information to a remote AE (MPPS server). It is associated with the local real-world activities “Update Worklist” and “Acquire Images”. When the “Update Worklist” local real-world activity is performed the Workflow Application Entity queries a remote AE (worklist server) 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. When the “Acquire Images” local real-world activity is performed, the Workflow Application Entity creates and updates Modality Performed Procedure Step instances managed by a remote AE (MPPS server). Acquisition of images will result in automated creation of an MPPS Instance. Completion of the MPPS is performed as the result of the operator action of closing the 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-SCU AE will not try to initiate another association for the send-job automatically.

⁶ Q/R-SCU is supported starting with the MRI EVO’15 Update 1 software releases.

⁷ Verification-SCU is supported starting with the 1.1B E-MRI Vista software releases.

4.1.2.2 Functional Definition of Q/R-SCU Application Entity

A connection from the Q/R-SCU to the remote AE is established to execute a query of the remote archive using the decided criteria. When the user selects a study or series for retrieval, a connection to the remote AE is established to initiate and monitor the retrieval: a Store-SCP AE is activated to receive the retrieved instances.

4.1.2.3 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.

4.1.2.4 Functional Definition of QR-Storage-SCP Application Entity

The QR-Storage-SCP AE, activated when the user selects a study or series for retrieval, waits in the background for connections, accepts associations with Presentation Contexts for MR Image Storage only, and automatically stores the received instances to the local database.

4.1.2.5 Functional Definition of Verification Application Entity

Verification 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. It can also send echo requests to the configured Application Entities ⁷.

4.1.2.6 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. The results will be displayed in a separate list, which will be cleared with the next Worklist Update, if successful. The previously obtained worklist will be kept if for any reason a new one cannot be received: this is done to enable the use of the device also in case of network or server fault.

The Workflow AE performs the creation of a MPPS Instance automatically whenever images are acquired. When closing the exam, the MPPS "Completed" or "Discontinued" states can only be set from the user interface.

4.1.2.7 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

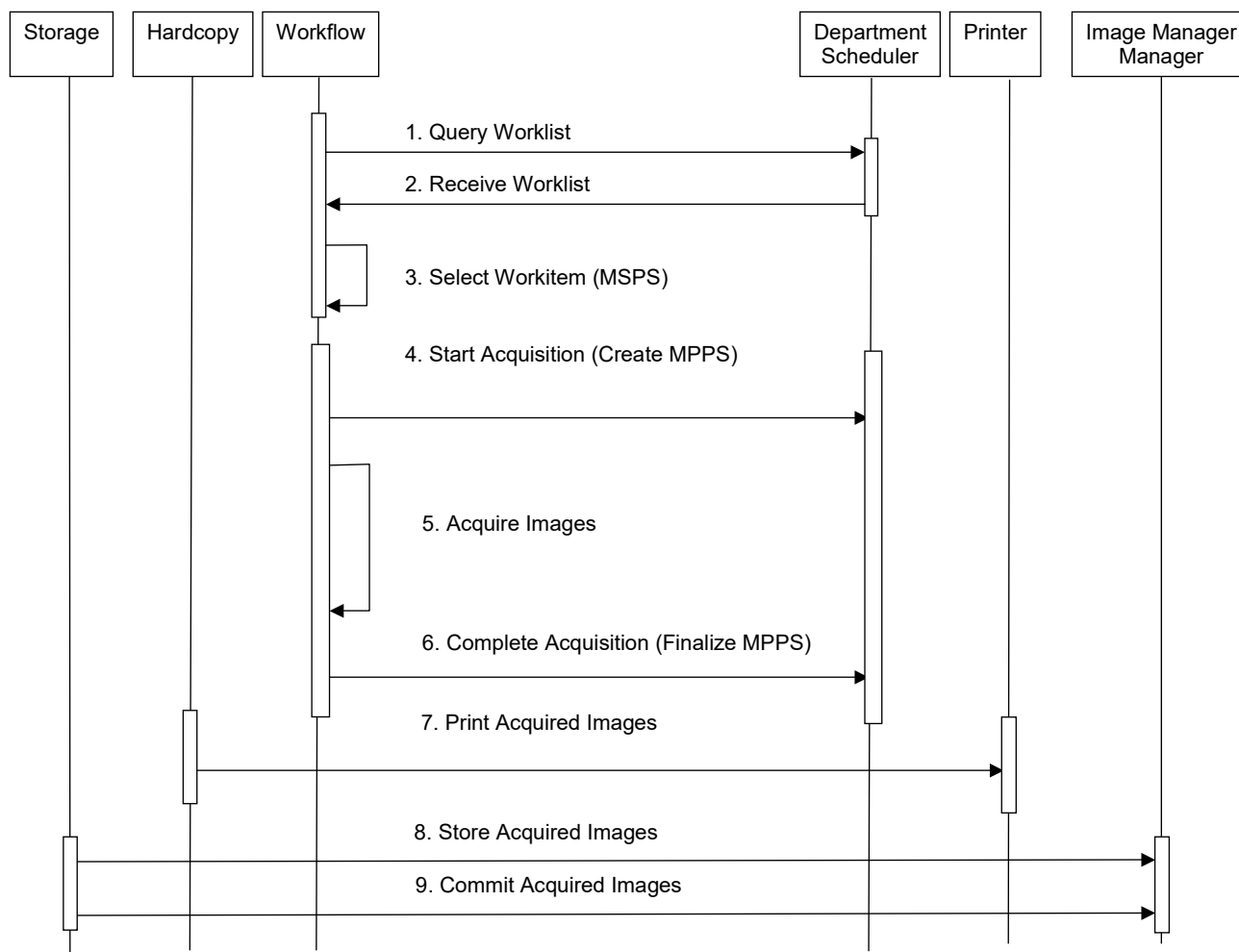


Figure 2
SEQUENCING CONSTRAINTS

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

1. Query Worklist.
2. Receive Worklist of Modality Scheduled Procedure Steps (MSPS).
3. Select Work item (MSPS) from Worklist.
4. Start acquisition and create MPPS.
5. Acquire Images.
6. Complete acquisition and finalize MPPS.
7. Print acquired images (optional step).
8. Store acquired images.
9. If there is a Storage Commitment server configured and enabled, the Storage-SCU AE will request Storage Commitment for the images to it.

Other workflow situations (e.g. unscheduled procedure steps) 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.

The Q/R-SCU and QR-Store-SCP activities are performed in a completely independent way from the above activities. The QR-Store-SCP activities are performed asynchronously in the background and not dependent on any sequencing. The Q/R-SCU activities are sequentially initiated in the user interface.

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
Grayscale Softcopy Presentation State Storage SOP Class ⁸	1.2.840.10008.5.1.4.1.1.11.1	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.

⁸ Since the software release 4.0A E-MRI Brio.

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. The associated GSPS objects, when present, will be sent together with the images if the corresponding option is enabled by the user. 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.

If there is a configured Storage Commitment SCP, the Storage-SCU AE will, after all images have been sent, transmit a single Storage Commitment request (N-ACTION) over another Association. Upon receiving the N-ACTION response the Storage-SCU AE will close the Association. However, the Storage-SCU AE is capable of receiving an N-EVENT-REPORT request at any time during an association provided a Presentation Context for the Storage Commitment Push Model has been successfully negotiated (i.e. the N-ACTION is sent at the end of one association and the N-EVENT-REPORT is received during an association initiated for a subsequent send job or during an association initiated by the Remote AE for the specific purpose of sending the N-EVENT-REPORT).

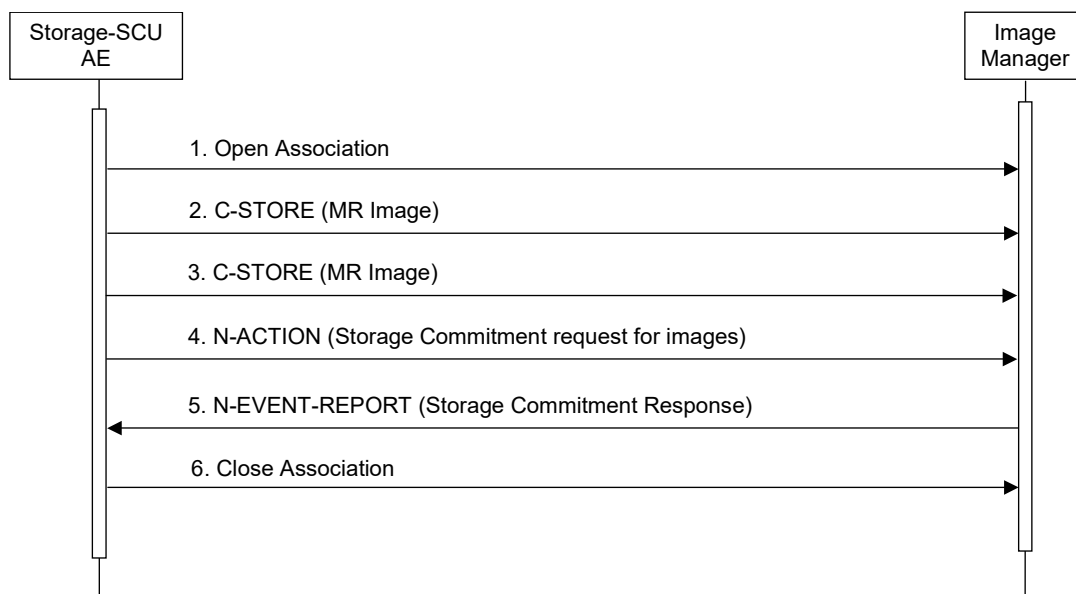


Figure 3
SEQUENCING OF ACTIVITY – SEND IMAGES

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. An N-ACTION request is transmitted to the Image Manager to obtain storage commitment of previously transmitted images. The Image Manager replies with a N-ACTION response indicating the request has been received and is being processed.
5. The Image Manager immediately transmits an N-EVENT-REPORT request notifying the Storage-SCU AE of the status of the Storage Commitment Request (sent in step 4 using the N-ACTION message). The Storage-SCU AE replies with a N-EVENT-REPORT response confirming receipt. The Image Manager could send this message at any time or omit it entirely in favor of transmitting the N-EVENT-REPORT over a separate dedicated association (see note).
6. 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. The N-EVENT-REPORT can also be sent over a separate association initiated by the Image Manager (see Section 4.2.1.4.1 on Activity – Receive Storage Commitment Response). The Storage SCP and the Storage Commitment SCP can be different systems.

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	1.2.840.10008.1.2 1.2.840.10008.1.2.1	SCU	None
Storage Commitment Push Model	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Grayscale Softcopy Presentation State Storage SOP Class ⁹	1.2.840.10008.5.1.4.1.1.11.1	Implicit VR Little Endian Explicit VR Little Endian	1.2.840.10008.1.2 1.2.840.10008.1.2.1	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:

⁹ Since the software release 4.0A E-MRI Brio.

**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.

4.2.1.3.1.4. SOP Specific Conformance for Storage Commitment SOP Class

Storage Commitment Operations (N-ACTION)

The Storage-SCU AE will request storage commitment for instances of the MR Image Storage SOP Class of a given study if there is a Remote AE configured as a Storage Commitment server (SCP) configured to work with the Storage Server SCP the images have been sent, and a presentation context for the Storage Commitment Push Model has been accepted.

The storage commitment will only be requested when sending a whole study, either manually from the image database, or automatically with the Auto Send feature; the storage commitment N-ACTION will be sent after all the images of the study have been sent. When sending one or more series or images the storage commitment will not be requested.

The Storage-SCU AE will consider Storage Commitment failed if no N-EVENT-REPORT is received for a Transaction UID within a configurable time period after receiving a successful N-ACTION response (duration of applicability for a Transaction UID).

The Storage-SCU AE does not send the optional Storage Media FileSet ID & UID Attributes or the Referenced Study Component Sequence Attribute in the N-ACTION.

The list of the jobs for which a Storage Commitment request (N-ACTION) has been successfully sent to the Storage Commitment SCP can be accessed opening the Storage log area of the User's Interface. When for all the images of a given study all the commitments have been successful (a successful N-EVENT-REPORT has been received for all the SOP Instances), in the image database the whole study is marked as "Committed", indicating also the Storage Commitment server involved.

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

**TABLE 13
STORAGE COMMITMENT N-ACTION RESPONSE STATUS HANDLING BEHAVIOR**

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The request for storage comment is considered successfully sent. A timer is started which will expire if no N-EVENT-REPORT for the Transaction UID is received within a configurable timeout period.
*	*	Any other status code.	The Association is aborted using A-ABORT and the request for storage commitment is marked as failed. The status meaning is logged and reported to the user via the job control application.

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

**TABLE 14
STORAGE COMMUNICATION FAILURE BEHAVIOR**

Exception	Behavior
Timeout	The Association is aborted using A-ABORT and the send job is marked as failed. The reason is logged and the job failure is reported to the user via the job control application.
Association aborted by the SCP or network layers	The send job is marked as failed. The reason is logged and the job failure is reported to the user via the job control application.

Storage Commitment Notifications (N-EVENT-REPORT)

The Storage-SCU AE is capable of receiving an N-EVENT-REPORT notification if it has successfully negotiated a Presentation Context for the Storage Commitment Push Model.

Upon receipt of a N-EVENT-REPORT the timer associated with the Transaction UID will be canceled.

The behavior of Storage-SCU AE when receiving Event Types within the N-EVENT-REPORT is summarized in the Table below.

**TABLE 15
STORAGE COMMITMENT N-EVENT-REPORT BEHAVIOUR**

Event Type Name	Event Type ID	Behavior
Storage Commitment Request Successful	1	The Referenced SOP Instances under Referenced SOP Sequence (0008,1199) are marked as committed in the image database. When all the SOP Instances of the study are marked as committed, the whole study will get the "Committed" label. Successfully committed SOP Instances are candidates for deletion from the local database.
Storage Commitment Request Complete – Failures Exist	2	The Referenced SOP Instances under Referenced SOP Sequence (0008,1199) are treated in the same way as in the success case (Event Type 1). A send job that failed storage commitment will not be automatically restarted but can be restarted by user interaction.

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

**TABLE 16
STORAGE COMMITMENT N-EVENT-REPORT RESPONSE STATUS REASONS**

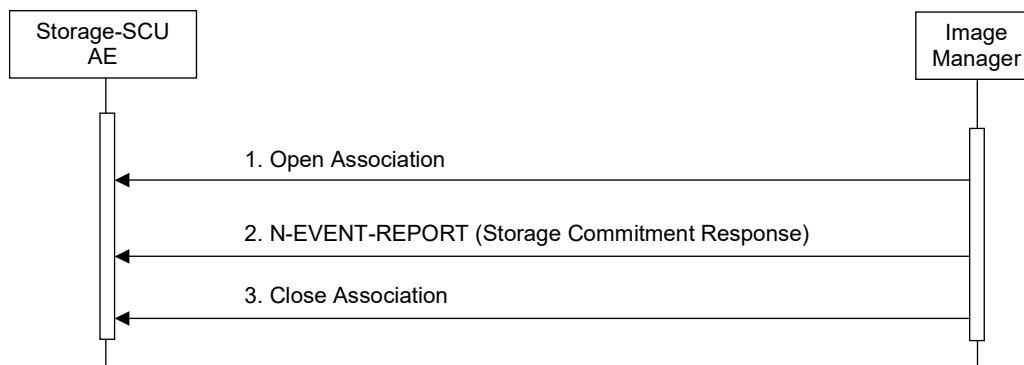
Service Status	Further Meaning	Error Code	Reasons
Success	Success	0000	The storage commitment result has been successfully received.
Failure	Unrecognized Operation	0211H	The Transaction UID in the N-EVENT-REPORT request is not recognized (was never issued within an N-ACTION request).
Failure	Resource Limitation	0213H	The Transaction UID in the N-EVENT-REPORT request has expired (no N-EVENT-REPORT was received within a configurable time limit).
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).
Failure	Invalid Argument Value	0115H	One or more SOP Instance UIDs with the Referenced SOP Sequence (0008,1199) or Failed SOP Sequence (0008,1198) was not included in the Storage Commitment Request associated with this Transaction UID. The unrecognized SOP Instance UIDs will be returned within the Event Information of the N-EVENT-REPORT response.

4.2.1.4 Association Acceptance Policy

4.2.1.4.1 Activity – Receive Storage Commitment Response

4.2.1.4.1.1. Description and Sequencing of Activities

The Storage-SCU AE will accept associations in order to receive responses to a Storage Commitment Request.



**Figure 4
SEQUENCING OF ACTIVITY - RECEIVE STORAGE COMMITMENT RESPONSE**

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

1. The Image Manager opens a new association with the Storage-SCU AE.
2. The Image Manager sends an N-EVENT-REPORT request notifying the Storage-SCU AE of the status of a previous Storage Commitment Request. The Storage-SCU AE replies with a N-EVENT-REPORT response confirming receipt.
3. The Image Manager closes the association with the Storage-SCU AE.

The Storage-SCU AE may reject association attempts as shown in the Table below. The Result, Source and Reason/Diag columns represent the values returned in the appropriate fields of an ASSOCIATE-RJ PDU

(see PS 3.8, Section 9.3.4). The contents of the Source column is abbreviated to save space and the meaning of the abbreviations are:

- a) 1 – DICOM UL service-user
- b) 2 – DICOM UL service-provider (ASCE related function)
- c) 3 – DICOM UL service-provider (Presentation related function)

**TABLE 17
ASSOCIATION REJECTION REASONS**

Result	Source	Reason/Diag	Explanation
2 – rejected-transient	c	2 – local-limit-exceeded	The (configurable) maximum number of simultaneous associations has been reached. An association request with the same parameters may succeed at a later time.
2 – rejected-transient	c	1 – temporary-congestion	No associations can be accepted at this time due to the real-time requirements of higher priority activities (e.g. during image acquisition no associations will be accepted) or because insufficient resources are available (e.g. memory, processes, threads). An association request with the same parameters may succeed at a later time.
1 – rejected-permanent	a	2 – application-context-name-not-supported	The association request contained an unsupported Application Context Name. An association request with the same parameters will not succeed at a later time.
1 – rejected-permanent	a	7 – called-AE-title-not-recognized	The association request contained an unrecognized Called AE Title. An association request with the same parameters will not succeed at a later time unless configuration changes are made. This rejection reason normally occurs when the association initiator is incorrectly configured and attempts to address the association acceptor using the wrong AE Title.
1 – rejected-permanent	a	3 – calling-AE-title-not-recognized	The association request contained an unrecognized Calling AE Title. An association request with the same parameters will not succeed at a later time unless configuration changes are made. This rejection reason normally occurs when the association acceptor has not been configured to recognize the AE Title of the association initiator.
1 – rejected-permanent	b	1 – no-reason-given	The association request could not be parsed. An association request with the same format will not succeed at a later time.

4.2.1.4.1.2. Accepted Presentation Contexts

The Storage-SCU AE will accept Presentation Contexts as shown in the Table below.

**TABLE 18
ACCEPTABLE PRESENTATION CONTEXTS FOR
ACTIVITY RECEIVE STORAGE COMMITMENT RESPONSE**

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Storage Commitment Push Model	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

The Storage-SCU AE will only accept the SCU role (which must be proposed via SCP/SCU Role Selection Negotiation) within a Presentation Context for the Storage Commitment Push Model SOP Class.

4.2.1.4.1.3. SOP Specific Conformance for Storage Commitment SOP Class Storage Commitment Notifications (N-EVENT-REPORT)

Upon receipt of a N-EVENT-REPORT the timer associated with the Transaction UID will be canceled, and the study that contains the Referenced SOP Instances under Referenced SOP Sequence (0008,1199) is marked within the image database as "Committed". Successfully committed SOP Instances are candidates for deletion from the local database.

The behavior of Storage-SCU AE when receiving Event Types within the N-EVENT-REPORT is summarized in Table 16.

The reasons for returning specific status codes in a N-EVENT-REPORT response are summarized in Table 17.

4.2.2 Q/R-SCU Application Entity Specification ¹⁰**4.2.2.1 SOP Classes**

The Q/R-SCU AE provides Standard Conformance to the following SOP Classes:

**TABLE 19
SOP CLASSES FOR Q/R-SCU AE**

SOP Class Name	SOP Class UID	SCU	SCP
Study Root Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1	Yes	No
Study Root Query/Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2	Yes	No

4.2.2.2 Association Policies**4.2.2.2.1 General**

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

**TABLE 20
DICOM APPLICATION CONTEXT FOR Q/R-SCU AE**

Application Context Name	1.2.840.10008.3.1.1.1
--------------------------	-----------------------

4.2.2.2.2 Number of Associations

The Q/R-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 21
NUMBER OF ASSOCIATIONS INITIATED FOR Q/R-SCU AE**

Maximum number of simultaneous Associations	1
---	---

The Q/R-SCU AE does not accept Associations.

**TABLE 22
NUMBER OF ASSOCIATIONS ACCEPTED FOR Q/R-SCU AE**

Maximum number of simultaneous Associations	0
---	---

4.2.2.2.3 Asynchronous Nature

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

**TABLE 23
ASYNCHRONOUS NATURE AS A SCU FOR Q/R-SCU AE**

Maximum number of outstanding asynchronous transactions	1
---	---

4.2.2.2.4 Implementation Identifying Information

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

¹⁰ Since the software release MRI EVO'15 Update 1.

4.2.2.3 Association Initiation Policy

The Q/R-SCU AE uses a list of valid query/retrieve servers. User can select one of them, the system saves these settings so the user does not need to set them for every request or after every startup.

The Q/R-SCU AE starts an association for every request of query or retrieval.
The system initiates a query operation in response to user activity.

4.2.2.3.1 Activity – Query Images

4.2.2.3.1.1. Description and Sequencing of Activities

The request for a query operation is initiated by user interaction, when the query is started on user request, or automatically. The data from the user interface will be inserted as matching keys into the query.

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

**TABLE 24
STUDY LEVEL QUERY MATCHING KEYS**

Tag	Attribute	Contents	Matching Key Type
(0008,0005)	Specific Character Set	always Local Specific Character Set, cannot be modified ¹¹	=
(0008,0052)	Query/Retrieve Level	always <i>STUDY</i>	R
(0008,0020)	empty, can be set	empty, can be set	R
(0008,0050)	Accession Number	empty, can be set	R
(0008,0061)	Modalities In Study	always <i>MR</i>	O
(0008,0090)	Referring Physician's Name	empty, can be set	O
(0010,0010)	Patient's Name	empty, can be set	R
(0010,0020)	Patient's ID	empty, can be set	R
(0020,0010)	Study ID	empty, can be set	R

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 29. Then it will initiate an Association to send the study level request and will wait for responses. After retrieval of all responses, the ESAOTE MRI system will prepare a list of the patients and studies found in the responses.

When expanding a study node of the previous list with the data selected from the responses, a narrow series level query will be sent requesting the series that fulfills the matching keys in the table below:

**TABLE 25
SERIES LEVEL QUERY MATCHING KEYS**

Tag	Attribute	Contents	Matching Key Type
(0008,0052)	Query/Retrieve Level	always <i>SERIES</i>	R
(0008,0060)	Modality	always <i>MR</i>	O
(0020,000D)	Study Instance UID	from the selected result of the broad query	O

¹¹ Since the software release MRI EVO' 21.

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 29. Then it will initiate an Association to send the series level request and will wait for responses. After retrieval of all responses, the ESAOTE MRI system will prepare a list of the series found in the responses.

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 Study Root Query/Retrieve Information Model.

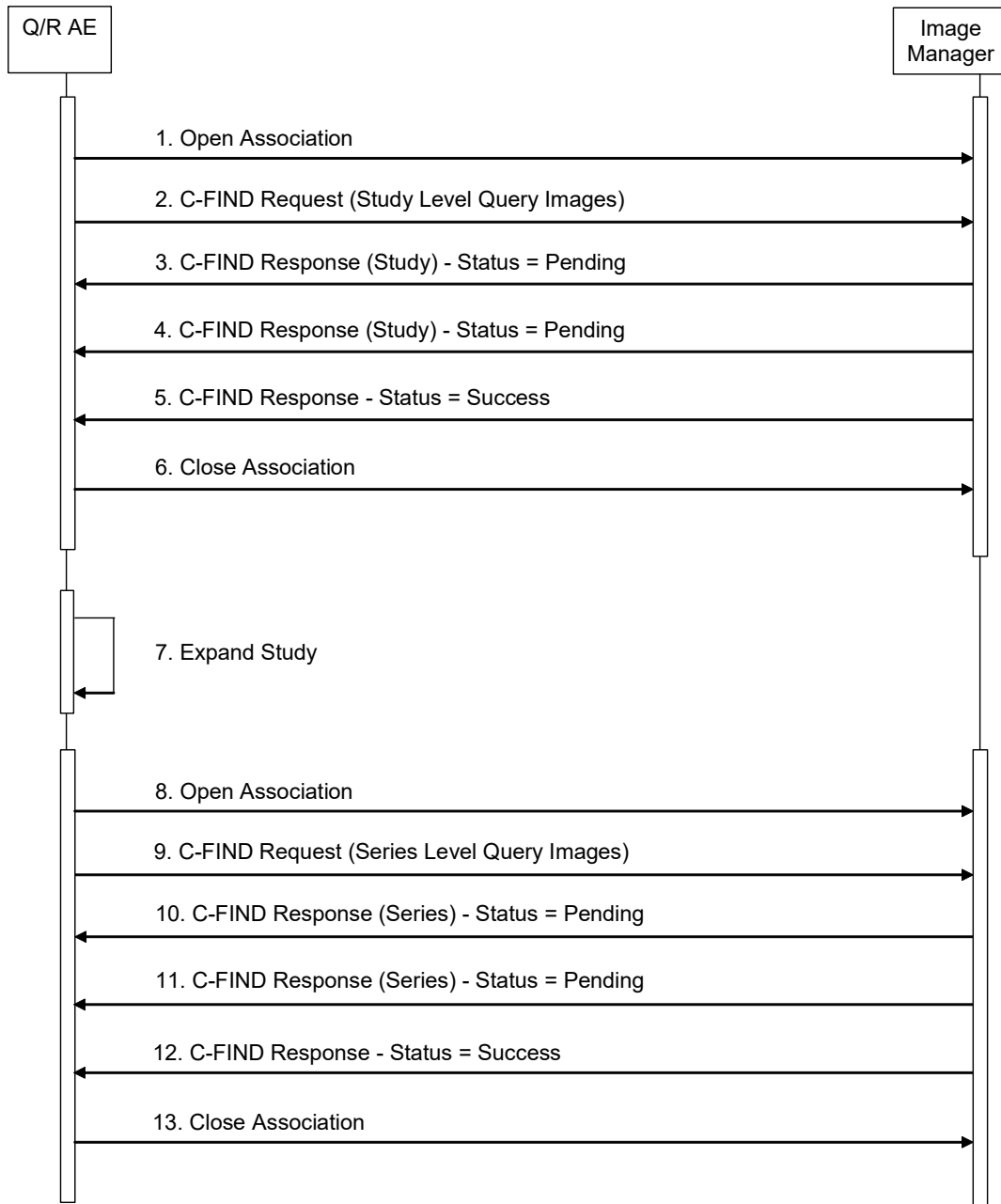


Figure 5
SEQUENCING OF ACTIVITY – QUERY IMAGES

A possible sequence of interactions between the Q/R AE and an Image Manager is illustrated in the Figure above:

1. The Q/R AE opens an association with the Image Manager.

2. The Q/R AE sends a Study Level C-FIND request to the Image Manager containing the Images Query attributes.
3. The Image Manager returns a C-FIND response containing the requested attributes of the first matching Item.
4. The Image Manager returns another C-FIND response containing the requested attributes of the second matching Item.
5. The Image Manager returns another C-FIND response with status Success indicating that no further matching Items exist. This example assumes that only 2 items match the Study Level Query.
6. The Q/R AE closes the association with the Image Manager.
7. The user expands a Study from the list.
8. The Q/R AE opens an association with the Image Manager.
9. The Q/R AE sends a Series Level C-FIND request to the Image Manager containing the Images Query attributes.
10. The Image Manager returns a C-FIND response containing the requested attributes of the first matching Item.
11. The Image Manager returns another C-FIND response containing the requested attributes of the second matching Item.
12. The Image Manager returns another C-FIND response with status Success indicating that no further matching Items exist. This example assumes that only 2 items match the Series Level Query.

4.2.2.3.1.2. Proposed Presentation Contexts

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

**TABLE 26
PROPOSED PRESENTATION CONTEXTS FOR ACTIVITY QUERY IMAGES**

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Study Root Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

4.2.2.3.1.3. SOP Specific Conformance for Query Images

The behavior of the ESAOTE MRI system when encountering status codes in a Query Images 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 27
QUERY IMAGES C-FIND RESPONSE STATUS HANDLING BEHAVIOR**

Service Status	Further Meaning	Error Code	Behavior
Success	Matching is complete	0000	The SCP has completed the matches. 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	A900	The status meaning is logged and an error is reported to the user.

	match SOP Class		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 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 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 28
QUERY IMAGES COMMUNICATION FAILURE BEHAVIOR**

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

The Table below provides a description of the ESAOTE MRI Images Query Identifier. Unexpected attributes returned in a C-FIND response are ignored.

**TABLE 29
IMAGES QUERY IDENTIFIER**

Attribute Name	Tag	VR	M	R	Q	D
Query/Retrieve Level	(0008,0052)	CS	S			
Q/R Study Level						
Study Date	(0008,0020)	DA	R		x	x
Study Time	(0008,0030)	TM		x		x
Accession Number	(0008,0050)	SH		x	x	x
Modalities In Study	(0008,0061)	CS	S			
Referring Physician's Name	(0008,0090)	PN		x	x	x
Study Description	(0008,1030)	LO		x		x
Patient's Name	(0010,0010)	PN		x	x	x
Patient's ID	(0010,0020)	LO		x	x	x
Patient's Birth Date	(0010,0030)	DA		x		x
Patient's Sex	(0010,0040)	CS		x		x
Study Instance UID	(0020,000D)	UI		x		

Attribute Name	Tag	VR	M	R	Q	D
Study ID	(0020,0010)	SH		x	x	x
Number of Study Related Series	(0020,1206)	IS		x		
Number of Study Related Instances	(0020,1208)	IS		x		
Q/R Series Level						
Series Date	(0008,0021)	DA		x		x
Modality	(0008,0060)	CS	S			
Series Description	(0008,103E)	LO		x		x
Body Part Examined	(0018,0015)	CS		x		
Study Instance UID	(0020,000D)	UI				
Series Instance UID	(0020,000E)	UI		x		
Series Number	(0020,0011)	IS		x		x
Number of Series Related Instances	(0020,1209)	IS		x		
Performed Procedure Step Start Date	(0040,0244)	DA		x		
Performed Procedure Step Start Time	(0040,0245)	TM		x		
Request Attributes Sequence	(0040,0275)	SQ		x		

The above table should be read as follows:

Attribute Name: Attributes supported to build an ESAOTE MRI system Image Query Identifier.

Tag: DICOM tag for this attribute.

VR: DICOM VR for this attribute.

M: Matching keys for Image Query. 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. "Modality" and "Modalities In Study" are 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. An "x" will indicate that the ESAOTE MRI system will supply this attribute as matching key, if entered into the user interface.

D: Displayed keys. An "x" indicates that this attribute is displayed in the user interface.

4.2.2.3.2 Activity – Retrieve Images

4.2.2.3.2.1. Description and Sequencing of Activities

The request for a retrieve operation is initiated by user interaction pressing the button "Retrieve".

When the retrieval is started on user request, the data from the user interface will be inserted as matching keys into the request in order to retrieve images on a remote system by moving matching images from the remote database to the local database.

For the retrieves, the ESAOTE MRI system will initiate an Association in order to issue a C-MOVE request according to the Study Root Query/Retrieve Information Model.

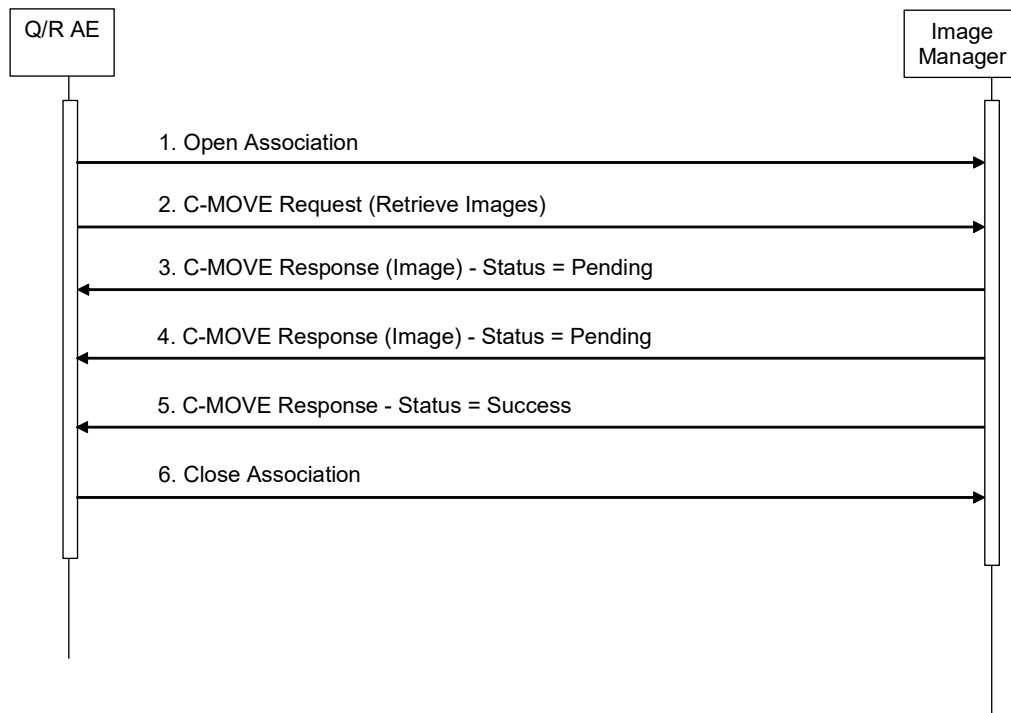


Figure 6
SEQUENCING OF ACTIVITY – RETRIEVE IMAGES

A possible sequence of interactions between the Q/R AE and an Image Manager is illustrated in the Figure above:

1. The Q/R AE opens an association with the Image Manager.
2. The Q/R AE sends a C-MOVE request to the Image Manager containing the Images Query attributes.
3. The Image Manager returns a C-MOVE response containing the requested attributes of the first matching Item.
4. The Image Manager returns another C-MOVE response containing the requested attributes of the second matching Item.
5. The Image Manager returns another C-MOVE response with status Success indicating that no further matching Items exist. This example assumes that only 2 items match the Study Level Query.
6. The Q/R AE closes the association with the Image Manager.

4.2.2.3.2.2. Proposed Presentation Contexts

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

**TABLE 30
PROPOSED PRESENTATION CONTEXTS FOR ACTIVITY RETRIEVE IMAGES**

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Study Root Query/Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

4.2.2.3.2.3. SOP Specific Conformance for Retrieve Images

The behavior of the ESAOTE MRI system when encountering status codes in a Retrieve Images C-MOVE 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 "retrieve failed" will appear on the user interface.

**TABLE 31
RETRIEVE IMAGES C-MOVE RESPONSE STATUS HANDLING BEHAVIOR**

Service Status	Further Meaning	Error Code	Behavior
Success	The moving is complete	0000	The SCP has completed to transfer stored SOP Instances. The status is reported to the user.
Refused	Out of Resources - Unable to calculate number of matches	A701	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.
Refused	Out of Resources - Unable to perform sub-operations	A702	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.
Refused	Move Destination Unknown	A801	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	Sub-operations terminated due to Cancel indication	FE00	The status meaning is logged and an error is reported to the user. Any additional error information in the Response will be logged.
Warning	Sub-operations Complete – One or more Failures	B000	The status meaning is logged and a warning is reported to the user. Any additional warning information in the Response will be logged.
Pending	Sub-operations are continuing	FF00	The item contained in the Identifier is collected for later display or further processing.
*	*	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.

**TABLE 32
RETRIEVE IMAGES COMMUNICATION FAILURE BEHAVIOR**

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

Table 33 provides a description of the IMAGES RETRIEVE request identifiers sent by the ESAOTE MRI system. Empty cells in the STUDY LEVEL and SERIES LEVEL columns indicate that the attribute is not sent. An "x" indicates that an appropriate value will be sent. A "Zero length" attribute will be sent with zero length.

**TABLE 33
IMAGES RETRIEVE IDENTIFIER**

Attribute Name	Tag	VR	STUDY LEVEL	SERIES LEVEL
Query/Retrieve Level	(0008,0052)	CS	<i>STUDY</i>	<i>SERIES</i>
Move Destination	(0000,0600)	AE	Local AET	Local AET
Priority	(0000,0700)	US	2	2
Study Instance UID	(0020,000D)	UI	x	x
Series Instance UID	(0020,000E)	UI		x

4.2.2.4 Association Acceptance Policy

The Q/R-SCU AE does not accept Associations.

4.2.3 Storage-SCP and QR-Storage-SCP Application Entities Specification

Storage-SCP and QR-Storage-SCP are very similar but independent. The first is always active and receives unsolicited objects from a remote Storage SCU, while QR-Storage-SCP is only active when a retrieve operation has been started, and only accepts the SOP Instances required by the Q/R-SCU.

In the following paragraphs everything written for the Storage-SCP AE is also valid for the QR-Storage-SCP unless specified.

4.2.3.1 SOP Classes

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

**TABLE 34
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
Grayscale Softcopy Presentation State Storage ¹²	1.2.840.10008.5.1.4.1.1.11.1	No	Yes

4.2.3.2 Association Policies

4.2.3.2.1 General

Storage-SCP accepts but never initiates associations.

**TABLE 35
MAXIMUM PDU SIZE RECEIVED AS A SCP FOR STORAGE-SCP AE**

Maximum PDU size received	28672
---------------------------	-------

4.2.3.2.2 Number of Associations

**TABLE 36
NUMBER OF ASSOCIATIONS AS A SCP FOR STORAGE-SCP AE**

Maximum number of simultaneous associations	20
---	----

4.2.3.2.3 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.

4.2.3.2.4 Implementation Identifying Information

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

4.2.3.3 Association Initiation Policy

The Storage-SCP does not initiate associations.

4.2.3.4 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.

¹² Since the software release 4.0A E-MRI Brio.

4.2.3.4.1 Activity – Receive Storage Request**4.2.3.4.1.1. 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. The Presentation State objects not produced by ESAOTE MRI systems will not be accepted.

4.2.3.4.1.2. Accepted Presentation Contexts

TABLE 37
ACCEPTABLE PRESENTATION CONTEXTS FOR
STORAGE-SCP AE RECEIVED STORAGE REQUESTS

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
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		
Grayscale Softcopy Presentation State Storage ¹³	1.2.840.10008.5.1.4.1.1.11.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		

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.

4.2.3.4.1.3. 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

¹³ Since the software release 4.0A E-MRI Brio; the Presentation State objects not produced by ESAOTE MRI systems will not be accepted.

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. Please note that the Presentation State objects not produced by ESAOTE MRI systems will not be accepted (Status code C000).

TABLE 38
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. ¹⁴
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	

¹⁴ Also used to reject GSPS objects not produced by ESAOTE MRI systems.

4.2.4 Verification Application Entity Specification ¹⁵**4.2.4.1 SOP Classes**

Verification AE provides Standard Conformance to the following SOP Classes:

**TABLE 39
SOP CLASSES SUPPORTED BY VERIFICATION AE**

SOP Class Name	SOP Class UID	SCU	SCP
Verification SOP Class	1.2.840.10008.1.1	Yes	Yes

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 40
DICOM APPLICATION CONTEXT AS A SCU FOR VERIFICATION AE**

Application Context Name	1.2.840.10008.3.1.1.1
--------------------------	-----------------------

4.2.4.2.2 Number of Associations

Verification AE initiates one Association at a time for a Verification request.

**TABLE 41
NUMBER OF ASSOCIATIONS INITIATED FOR VERIFICATION AE**

Maximum number of simultaneous Associations	1
---	---

**TABLE 42
NUMBER OF ASSOCIATIONS ACCEPTED FOR VERIFICATION AE**

Maximum number of simultaneous associations	20
---	----

4.2.4.2.3 Asynchronous Nature

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

4.2.4.2.4 Implementation Identifying Information

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

4.2.4.3 Association Initiation Policy**4.2.4.3.1 Activity – Send Echo request****4.2.4.3.1.1. Description and Sequencing of Activities**

Verification AE is invoked to send an Echo request by user interaction, pressing the button “Verify” in the DICOM configuration web pages where there are the DICOM server lists (i.e. Department Schedulers, Image Managers, Printers, etc.).

A message indicating the success or failure of the operation will be shown.

¹⁵ Verification-SCU is supported starting with the 1.1B E-MRI Vista software releases.

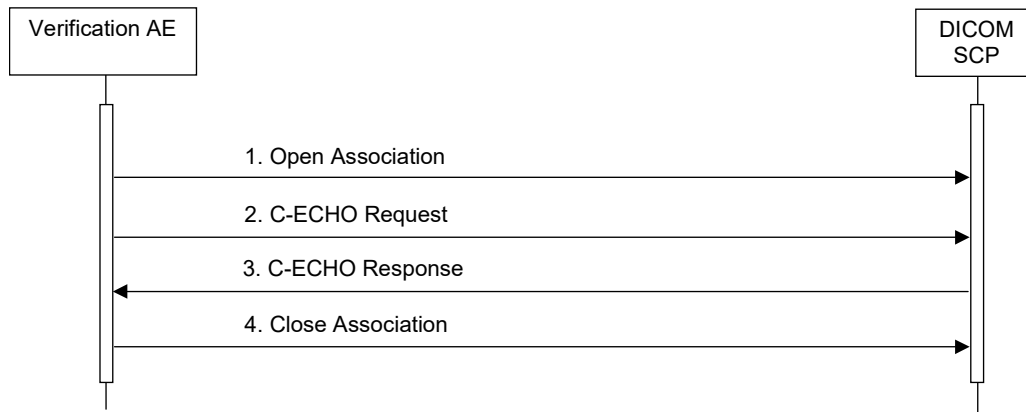


Figure 7
SEQUENCING OF ACTIVITY – SEND ECHO REQUEST

In the figure above a possible interaction between the Verification AE and a DICOM SCP Server is shown.

4.2.4.3.1.2. Proposed Presentation Contexts

The ESAOTE MRI system Verification AE is capable of proposing the Presentation Contexts shown in the following table:

TABLE 43
PROPOSED PRESENTATION CONTEXTS FOR SEND ECHO REQUEST

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

4.2.4.3.1.3. SOP Specific Conformance for Send Echo Request

Verification AE provides standard conformance to the Verification Service Class as an SCU.

The status code for the C-ECHO is summarized in the Table below:

TABLE 44
C-ECHO RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The C-ECHO request is accepted.

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

TABLE 45
SEND ECHO REQUEST FAILURE BEHAVIOR

Exception	Behavior
Timeout	A message indicating the reason of the failure of the operation is logged and reported to the user.
Association aborted by the SCP or network layers	A message indicating the result of the operation will be logged and reported to the user.

4.2.4.4 Association Acceptance Policy

When Verification 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.

4.2.4.4.1 Activity – Receive Echo Request

4.2.4.4.1.1. Description and Sequencing of Activities

The system listens on the Storage-SCP port only when the Storage-SCP is enabled, while it always listens on the Storage Commitment-SCU port. Associations are accepted from any calling AE Title.

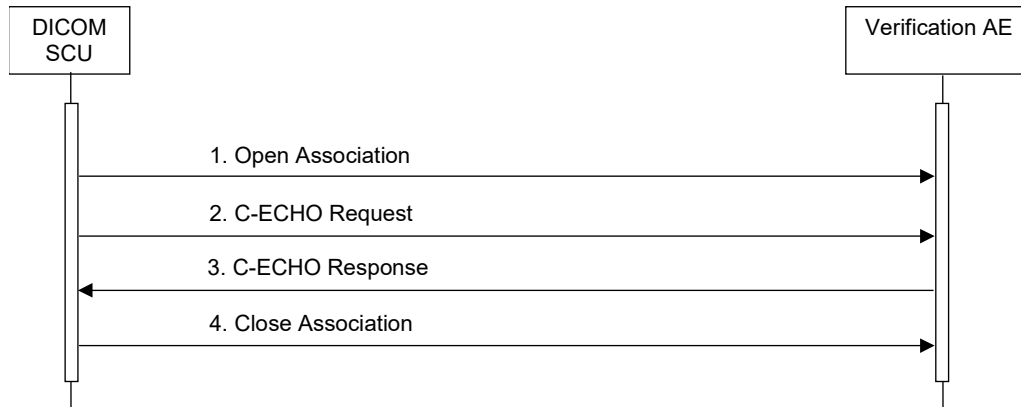


Figure 8
SEQUENCING OF ACTIVITY – RECEIVE ECHO REQUEST

4.2.4.4.1.2. Accepted Presentation Contexts

TABLE 46
ACCEPTABLE PRESENTATION CONTEXTS FOR VERIFICATION 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

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.

4.2.4.4.1.3. SOP Specific Conformance

SOP Specific Conformance to Verification SOP Class

Verification AE provides standard conformance to the Verification Service Class.

Presentation Context Acceptance Criterion

Verification 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

Verification 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.

Verification 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.

4.2.5 Workflow Application Entity Specification

4.2.5.1 SOP Classes

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

**TABLE 47
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
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3	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 48
DICOM APPLICATION CONTEXT FOR AE WORKFLOW**

Application Context Name	1.2.840.10008.3.1.1.1
--------------------------	-----------------------

4.2.5.3 Number of Associations

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

**TABLE 49
NUMBER OF ASSOCIATIONS INITIATED FOR AE WORKFLOW**

Maximum number of simultaneous Associations	1
---	---

4.2.5.3.1 Asynchronous Nature

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

**TABLE 50
ASYNCHRONOUS NATURE AS A SCU FOR AE WORKFLOW**

Maximum number of outstanding asynchronous transactions	1
---	---

4.2.5.3.2 Implementation Identifying Information

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

4.2.5.4 Association Initiation Policy

4.2.5.4.1 Activity – Worklist Update

4.2.5.4.1.1. 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 51
BROAD WORKLIST QUERY MATCHING KEYS**

Tag	Attribute	Contents
(0008,0005)	Specific Character Set	always Local Specific Character Set ¹⁶
(0040,0002)	Scheduled Procedure Step Start Date	present date, can be modified
(0008,0060)	Modality	always <i>MR</i>
(0040,0001)	Scheduled Station AE Title	Local AE Title, can be modified
(0010,0010)	Patient's Name	empty, can be set
(0008,0050)	Accession Number	empty, can be set
(0040,1001)	Request Procedure ID	empty, can be set

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 56. 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 52
NARROW WORKLIST QUERY MATCHING KEYS**

Tag	Attribute	Contents	Matching Key Type
(0008,0005)	Specific Character Set	from the selected result of the broad query ¹⁶	=
(0040,0002)	Scheduled Procedure Step Start Date	the same used in the broad query	R
(0008,0060)	Modality	always <i>MR</i>	R
(0040,0001)	Scheduled Station AE Title	the same used in the broad query	R
(0010,0020)	Patient ID	from the selected result of 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 56. 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 filters 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.

¹⁶ Since the software release MRI EVO' 21. Not intended to be a matching key.

When any C-FIND-RSP contains a different character set of the one in the query, a warning will result and the strings containing characters that cannot be mapped into the current character will not be inserted. When the any C-FIND-RSP does not contain the (0008,0005) Specific Character Set, the received data are treated as their (0008,0005) Specific Character Set correspond to the current settings of the Esaote MRI system.

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, asking the User to select again the study.

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.

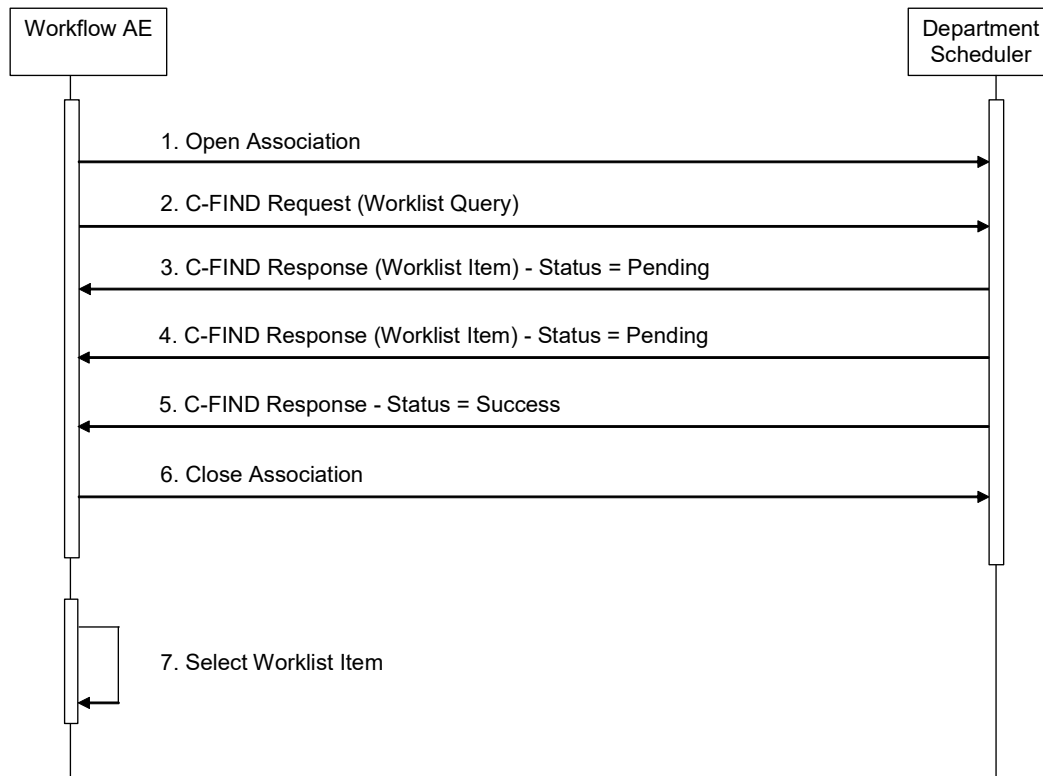


Figure 9
SEQUENCING OF ACTIVITY – WORKLIST UPDATE

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.

4.2.5.4.1.2. Proposed Presentation Contexts

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

**TABLE 53
PROPOSED PRESENTATION CONTEXTS FOR ACTIVITY WORKLIST UPDATE**

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Modality Worklist Information Model – FIND	1.2.840.10008.5.1.4.31	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

4.2.5.4.1.3. 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 54
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 55
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
- (0040,0007) Scheduled Procedure Step Description or
- (0040,0008) Scheduled Procedure Step Code Sequence

**TABLE 56
WORKLIST REQUEST IDENTIFIER**

Module Name Attribute Name	Tag	VR	M	R	Q	D	IOD
SOP Common Specific Character Set	(0008,0005)	CS	S	x			
Scheduled Procedure Step Scheduled Procedure Step Sequence > Scheduled Station AET > Scheduled Procedure Step Start Date > Scheduled Procedure Step Start Time > Modality > Scheduled Procedure Step Description > Scheduled Protocol Code Sequence > Scheduled Procedure Step ID	(0040,0100) (0040,0001) (0040,0002) (0040,0003) (0008,0060) (0040,0007) (0040,0008) (0040,0009)	SQ AE DA TM CS LO SQ SH	(S) R S	x x x x x x x x	x x x x x x x x	x x x x x x x x	x x x x x x x x
Requested Procedure Requested Procedure ID Requested Procedure Description Study Instance UID Referenced Study Sequence Requested Procedure Code Sequence	(0040,1001) (0032,1060) (0020,000D) (0008,1110) (0032,1064)	SH LO UI SQ SQ		x x x x x	x x x x x	x x x x x	x x x x x

Module Name Attribute Name	Tag	VR	M	R	Q	D	IOD
Imaging Service Request Accession Number Referring Physician's Name	(0008,0050) (0008,0090)	SH PN		x x	x x	x x	x x
Visit Admission Admitting Diagnoses Description	(0008,1080)	LO		x		x	x
Patient Identification Patient's Name Patient ID	(0010,0010) (0010,0020)	PN LO		x x	x	x x	x x
Patient Demographic Patient's Birth Date Patient's Sex Patient's Size Patient's Weight Occupation Patient Comments	(0010,0030) (0010,0040) (0010,1020) (0010,1030) (0010,2180) (0010,4000)	DA CS DS DS LO LT		x x x x x x		x x	x x x x 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. The "Specific Character Set" is set to Local Specific Character Set (broad query) or to selected result of the broad query (narrow query) and it is not intended to be a matching key.

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.

4.2.5.4.2 Activity – Acquire Images

4.2.5.4.2.1 Description and Sequencing of Activities

Selecting an item from in the WORKLIST QUERY panel fills the Patient Data panel; when pressing "Open Study", the narrow query is issued and in case of success you can modify or input the other relevant information about the exam to perform.

The trigger to create a MPPS SOP Instance is derived from pressing “Scout” in the above panel. An Association to the configured MPPS SCP system is established immediately and the related MPPS SOP Instance will be created.

When closing the current exam (“Close Study” button) the MPPS will be set to the final state “COMPLETED”. It is also possible to set it to “DISCONTINUED”, allowing the capability to set the correct PPS Discontinuation Reason Code Sequence.

Starting an exam for a locally registered Patient will create an “unscheduled case”, by allowing MPPS Instances to be communicated for locally registered Patients.

The ESAOTE MRI system only supports a 0-to-1 relationship between Scheduled and Performed Procedure Steps.

The ESAOTE MRI system will initiate an Association to issue an:

- N-CREATE request according to the CREATE Modality Performed Procedure Step SOP Instance operation or a
- N-SET request to update the contents and state of the MPPS according to the SET Modality Performed Procedure Step Information operation.

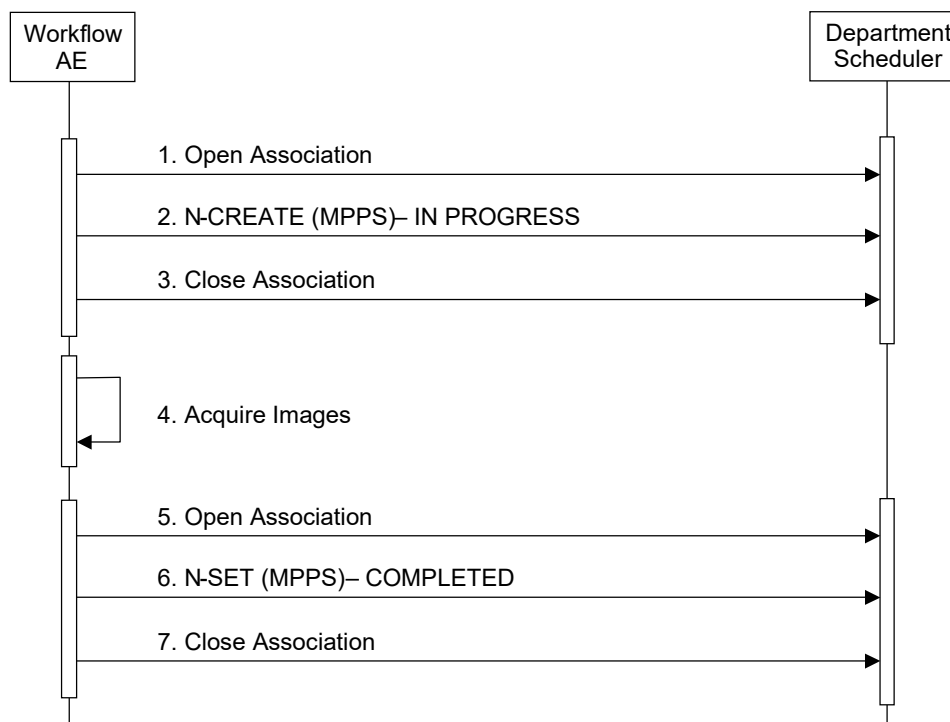


Figure 10
SEQUENCING OF ACTIVITY – ACQUIRE IMAGES

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 MPPS SOP Class as an SCP) is illustrated in Figure 10:

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

2. The Worklist AE sends an N-CREATE request to the Departmental Scheduler to create an MPPS instance with status of "IN PROGRESS" and create all necessary attributes. The Departmental Scheduler acknowledges the MPPS creation with an N-CREATE response (status success).
3. The Worklist AE closes the association with the Departmental Scheduler.
4. All images are acquired and stored in the local database.
5. The Worklist AE opens an association with the Departmental Scheduler.
6. The Worklist AE sends an N-SET request to the Departmental Scheduler to update the MPPS instance with status of "COMPLETED" and set all necessary attributes. The Departmental Scheduler acknowledges the MPPS update with an N-SET response (status success).
7. The Worklist AE closes the association with the Departmental Scheduler.

4.2.5.4.2.2. Proposed Presentation Contexts

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

TABLE 57
PROPOSED PRESENTATION CONTEXTS FOR REAL-WORLD ACTIVITY ACQUIRE IMAGES

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

4.2.5.4.2.3. SOP Specific Conformance for MPPS

The behavior of the ESAOTE MRI system when encountering status codes in an MPPS N-CREATE or N-SET response is summarized in Table 58. If any other SCP response status than "Success" or "Warning" is received by the ESAOTE MRI system, a message "MPPS update failed" will appear on the user interface.

TABLE 58
MPPS N-CREATE / N-SET RESPONSE STATUS HANDLING BEHAVIOR

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The SCP has completed the operation successfully.
Failure	Processing Failure – Performed Procedure Step Object may no longer be updated	0110	The Association is aborted using A-ABORT and the MPPS is marked as failed. The status meaning is logged and reported to the user. Additional information in the Response will be logged (i.e. Error Comment and Error ID).
Warning	Attribute Value Out of Range	0116H	The MPPS operation is considered successful but the status meaning is logged. Additional information in the Response identifying the attributes out of range will be logged (i.e. Elements in the Modification List/Attribute List)
*	*	Any other status code.	The Association is aborted using A-ABORT and the MPPS is marked as failed. The status meaning is logged and reported to the user.

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

**TABLE 59
MPPS COMMUNICATION FAILURE BEHAVIOR**

Exception	Behavior
Timeout	The Association is aborted using A-ABORT and MPPS marked as failed. The reason is logged and reported to the user.
Association aborted by the SCP or network layers	The MPPS is marked as failed. The reason is logged and reported to the user.

Table 60 provides a description of the MPPS N-CREATE and N-SET request identifiers sent by the ESAOTE MRI system. Empty cells in the N-CREATE and N-SET columns indicate that the attribute is not sent. An “x” indicates that an appropriate value will be sent. A “Zero length” attribute will be sent with zero length.

**TABLE 60
MPPS N-CREATE / N-SET REQUEST IDENTIFIER**

Attribute Name	Tag	VR	N-CREATE	N-SET Pending	N-SET Final State
Specific Character Set	(0008,0005)	CS	From Modality Worklist or Local Specific Character Set if empty in MWL. ¹⁷		
Modality	(0008,0060)	CS	MR		
Procedure Code Sequence	(0008,1032)	SQ	From Modality Worklist, contains the value of the Requested Procedure Code Sequence (0032,1064). Not present for unscheduled exams or if the User unchecks “Follow the Requested Procedure Code from Worklist” when starting the exam.	Same as for the N-CREATE.	Same as for the N-CREATE.
Referenced Patient Sequence	(0008,1120)	SQ	Zero length.		
Patient’s Name	(0010,0010)	PN	From Modality Worklist (all 5 components) or user input. The user cannot modify values provided via Modality Worklist.		
Patient ID	(0010,0020)	LO	From Modality Worklist or user input. The user cannot modify values provided via Modality Worklist.		
Patient’s Birth Date	(0010,0030)	DA	From Modality Worklist or user input. The user cannot modify values provided via Modality		

¹⁷ Since the software release MRI EVO’ 21. Before always “ISO_IR 100”.

			Worklist.		
Patient's Sex	(0010,0040)	CS	From Modality Worklist or user input. The user cannot modify values provided via Modality Worklist.		
Study ID	(0020,0010)	SH	Generated by the device. From Requested Procedure ID (0040,1001) when Modality Worklist is enabled.		
Performed Station AE Title	(0040,0241)	AE	Local AE Title.		
Performed Station Name	(0040,0242)	SH	Local station name.		
Performed Location	(0040,0243)	SH	Zero length.		
Performed Procedure Step Start Date	(0040,0244)	DA	Generated by the device.		
Performed Procedure Step Start Time	(0040,0245)	TM	Generated by the device.		
Performed Procedure Step End Date	(0040,0250)	DA	Zero length.		Actual end date.
Performed Procedure Step End Time	(0040,0251)	TM	Zero length.		Actual end time.
Performed Procedure Step Status	(0040,0252)	CS	"IN PROGRESS".	"IN PROGRESS".	"DISCONTINUED" or "COMPLETED".
Performed Procedure Step ID	(0040,0253)	SH	Generated by the device.		
Performed Procedure Step Description	(0040,0254)	LO	From the User Interface.	From the User Interface.	From the User Interface.
Performed Procedure Type Description	(0040,0255)	LO	Zero length.		
Performed Protocol Code Sequence	(0040,0260)	SQ	Zero length.		
Scheduled Step Attributes Sequence	(0040,0270)	SQ			
> Accession Number	(0008,0050)	SH	From Modality Worklist or user input. The user cannot modify values provided via Modality Worklist.		
> Referenced Study Sequence	(0008,1110)	SQ	From Modality Worklist, empty for unscheduled exams.		
>> Referenced SOP Class UID	(0008,1150)	UI	From Modality Worklist.		

>> Referenced SOP Instance UID	(0008,1155)	UI	From Modality Worklist.		
> Study Instance UID	(0020,000D)	UI	From Modality Worklist, automatically generated for unscheduled exams.		
> Requested Procedure Description	(0032,1060)	LO	From Modality Worklist, Zero length for unscheduled exams.		
> Scheduled Procedure Step Description	(0040,0007)	LO	From Modality Worklist, Zero length for unscheduled exams.		
> Scheduled Protocol Code Sequence	(0040,0008)	SQ	From Modality Worklist, Zero length for unscheduled exams.		
> Scheduled Procedure Step ID	(0040,0009)	SH	From Modality Worklist, Zero length for unscheduled exams.		
> Requested Procedure ID	(0040,1001)	SH	From Modality Worklist, Zero length for unscheduled exams.		
Performed Procedure Step Discontinuation Reason Code Sequence	(0040,0281)	SQ	Zero length.		From the User Interface, Context ID 9300.
Performed Series Sequence	(0040,0340)	SQ	Zero length.	One or more items.	One or more items.
> Retrieve AE Title	(0008,0054)	AE		Zero length.	Zero length.
> Series Description	(0008,103E)	LO		Generated by the device.	Generated by the device.
> Performing Physician's Name	(0008,1050)	PN		Zero length.	Zero length.
> Operator's Name	(0008,1070)	PN		Zero length.	Zero length.
> Referenced Image Sequence	(0008,1140)	SQ		One or more items.	One or more items.
>> Referenced SOP Class UID	(0008,1150)	UI		Generated by the device.	Generated by the device.
>> Referenced SOP Instance UID	(0008,1155)	UI		Generated by the device.	Generated by the device.
> Protocol Name	(0018,1030)	LO		According to the chosen protocol.	According to the chosen pre-set.
> Series Instance UID	(0020,000E)	UI		Generated by the device.	Generated by the device.
> Referenced Non-Image Composite SOP Instance Seq.	(0040,0220)	SQ		Zero length (SOP classes not supported).	Zero length (SOP classes not supported).

4.2.5.5 Association Acceptance Policy

The Workflow Application Entity does not accept Associations.

4.2.6 Hardcopy Application Entity Specification

4.2.6.1 SOP Classes

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

**TABLE 61
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

4.2.6.2 Association Policies

4.2.6.2.1 General

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

**TABLE 62
DICOM APPLICATION CONTEXT FOR AE HARDCOPY**

Application Context Name	1.2.840.10008.3.1.1.1
--------------------------	-----------------------

4.2.6.2.2 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 63
NUMBER OF ASSOCIATIONS INITIATED FOR AE HARDCOPY**

Maximum number of simultaneous Associations	number of configured hardcopy devices
---	---------------------------------------

4.2.6.2.3 Asynchronous Nature

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

**TABLE 64
ASYNCHRONOUS NATURE AS A SCU FOR AE HARDCOPY**

Maximum number of outstanding asynchronous transactions	1
---	---

4.2.6.2.4 Implementation Identifying Information

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

4.2.6.2.5 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 choose the most correct configuration parameters.

4.2.6.3 Association Initiation Policy

4.2.6.3.1 Activity – Film Images

4.2.6.3.1.1. 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.

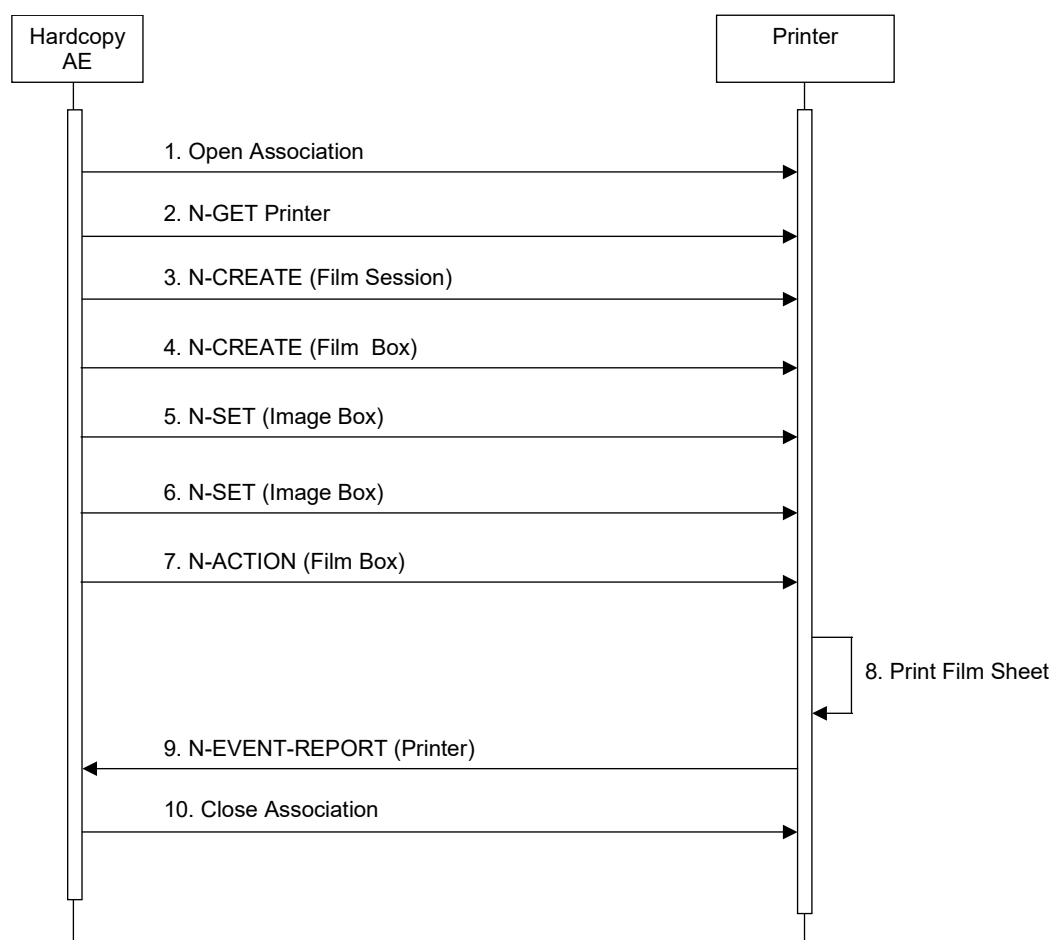


Figure 11
SEQUENCING OF ACTIVITY – FILM IMAGES

A typical sequence of DIMSE messages sent over an association between Hardcopy AE and a Printer is illustrated in Figure 11:

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.

4.2.6.3.1.2. Proposed Presentation Contexts

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

**TABLE 65
PROPOSED PRESENTATION CONTEXTS FOR ACTIVITY FILM IMAGES**

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

4.2.6.3.1.3. 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 66
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.

4.2.6.3.1.4. 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 67
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 68
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 69
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 70
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).

4.2.6.3.1.5. 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 71
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 72
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.

4.2.6.3.1.6. 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 73
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 74
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 75
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.

4.2.6.3.1.7. 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 76
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 77
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.

4.2.6.4 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 78
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 79
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 Vista Ultimate DHCP client is used, if enabled by the System Administrator: please refer to the Windows Vista Ultimate 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 80
AE TITLE CONFIGURATION TABLE

Application Entity	Default AE Title	Default TCP/IP Port
Storage-SCU	NmrEsaote	Not Applicable
Storage- SCP	NmrEsaote	104
QR-Storage-SCP	NmrEsaote	11113
Storage Commitment-SCU	NmrEsaote	11112
Verification	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 Q/R SCU

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

4.4.1.2.3 Storage-SCP

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

4.4.1.2.4 Verification

The Verification SCU is always available, while the Verification SCP is automatically enabled on Storage-SCP port if the Storage-SCP is enabled and is always enabled on Storage Commitment SCU port. Associations for the supported SOP Classes will be accepted from any calling AE Title.

4.4.1.2.5 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.

4.4.1.2.6 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 81
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	60 s
Time-out awaiting a Response to a DIMSE Request (Low-Level Timeout)	Yes	60 s

Parameter	Configurable (Yes/No)	Default Value
Time-out for waiting for data between TCP/IP-packets (Low Level Timeout)	No	60 s
Storage SCU 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-SCU AE	No	1
Supported Transfer Syntaxes (separately configurable for each remote AE)	No	See Table 10, not separately configurable
Q/R SCU Parameters		
Q/R SCU time-out waiting for the final response to a C-FIND-RQ	Yes	60 s
Q/R SCU time-out waiting for the final response to a C-MOVE-RQ	Yes	60 s
Supported Transfer Syntaxes for Query Images	No	See Table 26
Supported Transfer Syntaxes for Retrieve Images	No	See Table 30
Query for specific Modality Value	No	MR
Storage SCP Parameters		
Max PDU Size	No	28672 Bytes
STORAGE-SCP AE Maximum number of simultaneous Associations	No	5
STORAGE-SCP AE time-out waiting on an open Association for the next Request message (C-STORE-RQ, Association Close Request, etc.) (DIMSE timeout)	Yes	60 s
Permanent archival of SOP Instances sent unsolicited by a peer AE to the STORAGE-SCP AE (in a temporary archive, until a limit of 2500 images is reached)	No	TRUE
Storage Commitment Parameters		
Timeout waiting for a Storage Commitment Notification (maximum duration of applicability for a Storage Commitment Transaction UID).	Yes	3600 s
Maximum number of simultaneously accepted Associations by the Storage AE.	No	1
Delay association release after sending a Storage Commitment Request (wait for a Storage Commitment Notification over the same association).	No	0 s
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 53
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
MPPS Parameters		
MPPS SCU time-out waiting for a response to a N-CREATE-RQ	No	60 s

Parameter	Configurable (Yes/No)	Default Value
MPPS SCU time-out waiting for a response to a N-SET-RQ	No	60 s
Supported Transfer Syntaxes for MPPS	No	See Table 57.
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 65, 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

5.1 IMPLEMENTATION MODEL

5.1.1 Application Data Flow

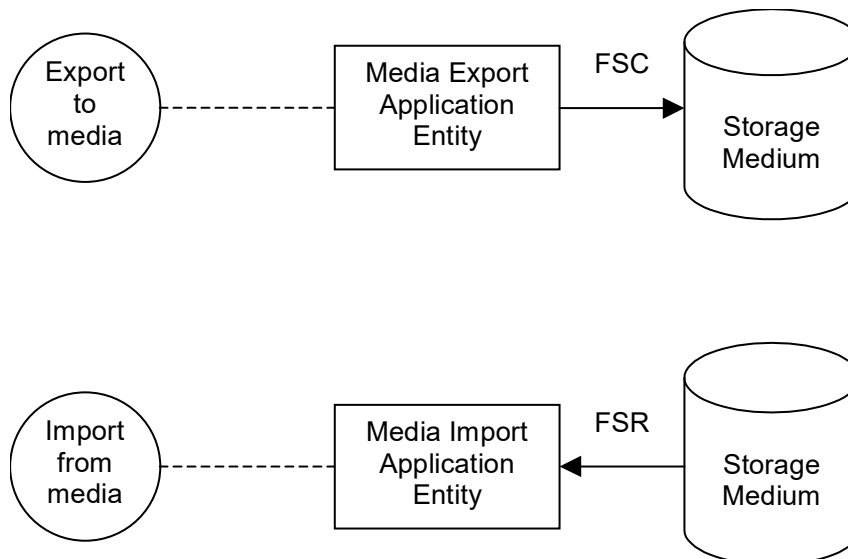


Figure 12

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.

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 82
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
STD-GEN-USB-JPEG	Export to USB	FSC, FSU

5.2.1.1 File Meta Information for the Application Entity

The Source Application Entity Title included in the File Meta Header is configurable (see section 5.3).

5.2.1.2 Real-World Activities

5.2.1.2.1 Activity – Export to CD-R or DVD or USB

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. Please note that only the CD-R (“Recordable Compact Disc”) and DVD devices allow to create DICOM compatible removable media according to the corresponding Media Application Profile(s) described in this section. Using something else, if present, can export the DICOM instances to non-standard archiving devices.

The Media Export Application Entity acts as a FSC when requested to export to a USB medium that does not contain a DICOM dataset; otherwise, if a DICOM dataset is present, it acts as a FSU. Please note that only devices formatted according to the FAT16 or FAT32 file systems are accepted by the DICOM standard, using anything else can export the DICOM instances to non-standard archiving devices.

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 among “Recordable Disk” (for CD-R and DVD) and “USB device” (this choice only appears when a USB medium is connected).

For CD-R and DVD, the above operation can be repeated as many times as needed, adding items to the list in the “Output” area; when all the wanted instances have been added, the user should insert the suitable medium and select the “Create CD” item in the pop-up menu of the “Output” area. If the suitable medium is not present, a message will appear asking to insert it. For USB medium the operation immediately starts, other instances can be queued, to be added to the USB device as soon as possible.

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

single-session CD-Rs or DVDs. Writing in multi-session mode is not supported. The user can cancel an export job in the job queue.

When checking the “Enable the jpeg format image export” in the “Export” tab of the “DICOM Options” panel, the medium will be produced using the IHE PDI Web Option.

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, STD-GEN-DVD-JPEG and STD-GEN-USB-JPEG Application Profiles.

Options

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

TABLE 83
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
Grayscale Softcopy Presentation State Storage ¹⁸	1.2.840.10008.5.1.4.1.1.1 1.1	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 84
APPLICATION PROFILES, ACTIVITIES AND ROLES FOR MEDIA IMPORT

Application Profiles Supported	Real World Activity	Role
STD-GEN-CD	Import from CD-R	FSR
STD-GEN-DVD-JPEG	Import from DVD	FSR
STD-GEN-USB-JPEG	Import from USB	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, DVD or USB

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

After inserting a CD-ROM or DVD or USB, in the “Device Management” area for the involved device the list of the patients will appear. The user, clicking on a patient, will see the list of the studies belonging to her;

¹⁸ Since the software release 4.0A E-MRI Brio. These objects are exported if the corresponding option is enabled by the user.

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, STD-GEN-DVD-JPEG and STD-GEN-USB-JPEG Application Profiles.

Options

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

TABLE 85
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
Grayscale Softcopy Presentation State Storage ¹⁹	1.2.840.10008.5.1.4.1.1.11.1	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 are included in the DICOMDIR, plus some Type 3 attributes of the Basic Directory IOD if present in the indexed objects..

AUGMENTED AND PRIVATE APPLICATION PROFILES

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

5.3 MEDIA CONFIGURATION

The Application Entity Title configurable for Media Services is the same used for the network storage as described in section 4.4.1.1.

¹⁹ Since the software release 4.0A E-MRI Brio. Only GSPS objects produced by ESAOTE MRI systems will be imported.

6 SUPPORT OF CHARACTER SETS

ESAOTE MRI system can be configured to support one of the following character set:

- ISO_IR 6 (US-ASCII)
- ISO_IR 100 (ISO 8859-1 Latin Alphabet No. 1)
- ISO_IR 101 (ISO 8859-2 Latin Alphabet No. 2)
- ISO_IR 109 (ISO 8859-3 Latin Alphabet No. 3)
- ISO_IR 110 (ISO 8859-4 Latin Alphabet No. 4)
- ISO_IR 126 (ISO 8859-7 Latin/Greek Alphabet)
- ISO_IR 127 (ISO 8859-6 Latin/Arabic Alphabet)
- ISO_IR 138 (ISO 8859-8 Latin/Hebrew Alphabet)
- ISO_IR 144 (ISO 8859-5 Latin/Cyrillic Alphabet)
- ISO_IR 192 (Unicode in UTF-8)
- GB18030 (Chinese)

In any case, the exams will be exported with the Specific Character Set that was in use in the system that acquired them at the moment they were acquired.

7 SECURITY

The ESAOTE MRI system supports only some 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.

7.1 SECURITY PROFILES

7.1.1 Security use Profiles

Not supported.

7.1.2 Security Transport Connection Profiles

Not supported.

7.1.3 Digital Signature Profiles

Not supported.

7.1.4 Media Storage Security Profiles

Not supported.

7.1.5 Attribute Confidentiality Profiles

7.1.5.1 Basic Application Level Confidentiality Profile

Esaote MRI system supports the Basic Application Level Confidentiality Profile as specified in DICOM 2021b PS3.15 Annex E.2.

The option to de-identify is available at the time of export to media (USB and CD/DVD).

7.1.5.1.1 Attributes removed or replaced

Table 86 lists the attributes altered during anonymization and the method used. This table is derived from DICOM 2021d PS3.15 Table E.1-1.

TABLE 86
ATTRIBUTES MODIFIED DURING DE-IDENTIFICATION

Attribute Name	Tag	De-Identification Action Code
Accession Number	(0008,0050)	Z
Image Date	(0008,0023)	Z
Image Time	(0008,0033)	Z
Acquisition Date	(0008,0022)	X
Acquisition Time	(0008,0032)	X
SOP Instance UID	(0008,0018)	U
Institution Name	(0008,0080)	X
Referring Physician Name	(0008,0090)	Z
Station Name	(0008,1010)	X
Study Date	(0008,0020)	Z
Study Time	(0008,0030)	Z
Study Description	(0008,1030)	X
Series Date	(0008,0021)	X
Series Time	(0008,0031)	X
Series Description	(0008,103e)	X
Institutional Department Name	(0008,1050)	X
Performing Physicians Name	(0008,1070)	X
Admitting Diagnoses Description	(0008,1090)	X
Referenced Study Sequence	(0008,1111)	X
Referenced Study Component Sequence	(0008,1140)	X
Referenced Image Sequence	(0008,2111)	X
Derivation Description	(0008,2112)	X
Patient Name	(0010,0010)	Z
Patient ID	(0010,0020)	Z
Patient Birth Date	(0010,0030)	X
Patient Sex	(0010,1040)	Z
Patient Size	(0010,1020)	X
Patient Weight	(0010,1030)	X

Occupation	(0010,2180)	X
Additional Patient History	(0010,21b0)	X
Patient Comments	(0010,4000)	X
Device Serial Number	(0018,1000)	X
Protocol Name	(0018,1030)	X
Study Instance UID	(0020,000d)	U
Series Instance UID	(0020,000e)	U
Study ID	(0020,0010)	Z
Frame of Reference UID	(0020,0052)	U
Image Comments	(0020,4000)	X
Request Attributes Sequence	(0040,0275)	X
Performed Procedure Step ID	(0040,0253)	X
Performed Procedure Step Description	(0040,0254)	X
Performed Procedure Step Date	(0040,0244)	X
Performed Procedure Step Time	(0040,0245)	X
Contrast Bolus Agent	(0018,0010)	Z

Description of the de-identification action codes used in the previous table:

- Z: replace with a zero length value, or a non-zero length value that may be a dummy value and consistent with the VR
- X: remove
- U: replace with a non-zero length UID that is internally consistent within a set of Instances

7.1.5.1.2 Encrypted Attributes Data Sets

Encryption of attributes for re-identification is not supported.

7.1.6 Network Address Management Profiles

Not supported.

7.1.7 Time Synchronization Profiles²⁰

Esaote MRI system conforms to the IHE Consistent Time Integration Profile.

It is possible to synchronize time with a NTP Time Server.

The ESAOTE MRI System Administrator tools must be used to enable synchronization, to set the port-number, host-name and polling period for the NTP Time Server. Only one NTP Timeserver can be defined.

7.1.8 Application Configuration Management Profiles

Not supported.

7.1.9 Audit Trail Profiles²⁰

It is possible to send messages to detect non-compliant behaviour and improper creation, access, modification and deletion of Protected Health Information (PHI) to a Syslog Server (Audit Record Repository)

²⁰ Since the software release MRI EVO' 21

The messages will be created and sent to a Syslog Server according to the syslog protocol. The time that is used will be the local time of the system which is synchronized with the NTP Time Server.

The following messages will be created and sent:

- Application Activity
- Begin Transferring DICOM Instances
- Data Export
- Data Import
- DICOM Instances Accessed
- DICOM Instances Transferred
- DICOM Study Deleted
- User Authentication

The ESAOTE MRI System Administrator tools must be used to enable sending of messages, to set the port-number and host-name for the Syslog server. Only one Syslog Server can be defined.

7.2 ASSOCIATION LEVEL SECURITY

Esaote MRI system accepts associations from unknown AEs but only for Storage-SCP and Verification-SCP.

Any support for security at the Association level is provided.

7.3 APPLICATION LEVEL SECURITY

Esaote MRI system supports security measures for

- Generation of audit trail records
- Access control and user authentication.

7.4 SECURE TRANSPORT CONNECTION

Esaote MRI system allows the use of either a conventional (non-secure) connection or a secure connection, based on the Transport Layer Security (TLS) protocol.

Esaote MRI system supports secure DICOM communication in conformance with the Basic TLS Secure Transport Connection Profile²⁰.

At default configuration the TLS option is deactivated.

TABLE 87
MECHANISM FOR TLS FEATURE

Supported TLS Feature	Minimum Mechanism
Entity Authentication	RSA based certificates
Exchange of Master Secrets	RSA
Data Integrity	SHA
Privacy	Triple DES EDE, DBC

When an integrity check fails, the connection will be dropped per the TLS protocol, causing both the sender and the receiver to issue an A-P-ABORT indication to the upper layers with an implementation-specific provider reason.

TLS authentication may only be used with TLS encryption.

Certificates are locally managed. The user may import certificates from media to the Esaote MRI system for verifying incoming certificates.

8 ANNEXES

8.1 IOD CONTENTS

8.1.1 Created SOP Instances

Table 88 specifies the attributes of the MR Images transmitted by the ESAOTE MRI system storage application. Table 89 specifies the attributes of the GSPS objects transmitted by the ESAOTE MRI system storage application when the corresponding option is enabled ²¹.

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 88
IOD OF MR CREATED SOP INSTANCES

IE	Module	Reference	Presence of Module
Patient	Patient	Table 90	ALWAYS
Study	General Study	Table 91	ALWAYS
	Patient Study	Table 95	ALWAYS
Series	General Series	Table 92	ALWAYS
Frame of Reference	Frame of Reference	Table 96	ALWAYS
Equipment	General Equipment	Table 93	ALWAYS
Image	General Image	Table 98	ALWAYS
	Image Plane	Table 99	ALWAYS
	Image Pixel	Table 100	ALWAYS
	Contrast/bolus	Table 101	ANAP
	MR Image	Table 102	ALWAYS
	VOI LUT	Table 103	ALWAYS
	SOP Common	Table 94	ALWAYS
	Private Application	Table 97	ALWAYS

8.1.1.2 GSPS IOD

TABLE 89
IOD OF GSPS CREATED SOP INSTANCES

IE	Module	Reference	Presence of Module
Patient	Patient	Table 90	ALWAYS
Study	General Study	Table 91	ALWAYS
Series	General Series	Table 92	ALWAYS
Equipment	General Equipment	Table 93	ALWAYS
Presentation State	Presentation State Identification	Table 104	ALWAYS
	Presentation State Relationship	Table 105	ALWAYS
	Display Shutter	Table 106	ANAP
	Displayed Area	Table 107	ALWAYS

²¹ GSPS available since the software release 4.0A E-MRI Brio.

	Graphic Annotation	Table 108	ANAP
	Spatial Transformation	Table 109	ALWAYS
	Graphic Layer	Table 110	ALWAYS
	Softcopy VOI LUT	Table 111	ALWAYS
	Softcopy Presentation LUT	Table 112	ALWAYS
	SOP Common	Table 94	ALWAYS

8.1.1.3 Common Modules

**TABLE 90
PATIENT MODULE OF CREATED 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) ²² .	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 ²³ .	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. For MR images only.	ANAP	MWL

**TABLE 91
GENERAL STUDY MODULE OF CREATED 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

²² For the ESAOTE MR veterinary systems in this attribute we put the name of the animal owner.

²³ 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).

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
Procedure Code Sequence	(0008,1032)	SQ	From Modality Worklist. Absent if empty in MWL or performed acquisition is different to what was scheduled.	ANAP	MWL
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 92
GENERAL SERIES MODULE OF CREATED SOP INSTANCES**

Attribute Name	Tag	VR	Value	Presence of Value	Source
Modality	(0008,0060)	CS	<i>MR</i> or <i>PR</i> .	ALWAYS	AUTO
Referenced Performed Procedure Step Sequence	(0008,1111)	SQ	Present only if scheduled from Modality Worklist and MPPS enabled.	ANAP	AUTO
> Referenced SOP Class UID	(0008,1150)	UI	1.2.840.10008.3.1.2.3.3 (Modality Performed Procedure Step SOP Class).	ANAP	AUTO
> Referenced SOP Instance UID	(0008,1155)	UI	Generated by device.	ANAP	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 (<i>L</i> or <i>R</i>).	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: <i>ELBOW, KNEE, ANKLE, HAND, FOOT, LEG, SHOULDER, HIP, ARM, CSPINE, SSPINE, LSPINE, THIGH, WRIST</i> (defined terms), <i>FOREARM, OTHER</i> (implementation-defined terms) ²⁴ .	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 Description	(0032,1060)	LO	From Modality Worklist.	ANAP	MWL

²⁴ See

Table 116 for the ESAOTE MR veterinary software releases.

>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	Generated by device. For MR images only.	ALWAYS	AUTO
Performed Procedure Step Start Date	(0040,0244)	DA	The same of the Study Date. For MR images only.	ALWAYS	AUTO
Performed Procedure Step Start Time	(0040,0245)	TM	The same of the Study Time. For MR images only.	ALWAYS	AUTO
Performed Procedure Step Description	(0040,0254)	LO	The same of the Study Description. For MR images only.	ANAP	AUTO

**TABLE 93
GENERAL EQUIPMENT MODULE OF CREATED SOP INSTANCES**

Attribute Name	Tag	VR	Value	Presence of Value	Source
Manufacturer	(0008,0070)	LO	ESAOTE.	ALWAYS	AUTO
Institution Name	(0008,0080)	LO	From System Administrator Configuration.	ALWAYS	CONFIG
Station Name	(0008,1010)	SH	From System Administrator Configuration.	ALWAYS	CONFIG
Institutional Department Name	(0008,1040)	LO	The Department, from System Administrator Configuration.	ALWAYS	CONFIG
Manufacturer's Model Name	(0008,1090)	LO	<i>G-scan, S-scan, G-scan Brio, Vet-MR Grande, G-ScanVet, Magnifico Open, Magnifico MSK, Magnifico Vet, O-scan, O-scan Equine and G-scan equine.</i>	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 94
SOP COMMON MODULE OF CREATED MR SOP INSTANCES**

Attribute Name	Tag	VR	Value	Presence of Value	Source
Specific Character Set	(0008,0005)	CS	From Modality Worklist or Local Specific Character Set if empty in MWL or local ²⁵	ALWAYS	AUTO
SOP Class UID	(0008,0016)	UI	According to the SOP Class (MR or GSPS)	ALWAYS	AUTO
SOP Instance UID	(0008,0018)	UI	Generated by device.	ALWAYS	AUTO

²⁵ Since the software release MRI EVO' 21. Before always "ISO_IR 100".

8.1.1.4 MR Image Modules

TABLE 95
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

TABLE 96
FRAME OF REFERENCE MODULE OF CREATED MR SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Frame of Reference UID	(0020,0052)	UI	A new value is generated each time a SCOUT is made.	ALWAYS	AUTO
Position Reference Indicator	(0020,1040)	LO	Not applicable for our kind of systems.	EMPTY	AUTO

TABLE 97
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
Receiving Bandwidth ²⁶	(0011,1008)	DS	Sampling frequency. Unit of measurement: hertz.	ALWAYS	AUTO

²⁶ Since the software release MRI EVO'17.0

TABLE 98
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 99
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 100
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 101
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 102
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; DERIVED\SECONDARY\IMAGE ADDITION and DERIVED\SECONDARY\IMAGE SUBTRACT (implementation defined term) for images produced combining other images.	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	<i>FFF</i> , <i>FPF</i> (defined terms) and <i>NONE</i> (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 or from user input.	ALWAYS	AUTO/ USER
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	<i>1H</i> .	ALWAYS	AUTO
Echo Number(s)	(0018,0086)	IS	According to the sequence. VM=1.	ALWAYS	AUTO
Magnetic Field Strength	(0018,0087)	DS	0.4T for Magnifico Open, Magnifico MSK and Magnifico Vet, 0.31T for O-scan and O-scan Equine, 0.25T for G-scan, S-scan, G-scan Brio, Vet-MR Grande G-Scan Vet and G-scan equine, 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
Pixel Bandwidth ²⁷	(0018,0095)	DS	According to the sequence.	ALWAYS	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

²⁷ Since the software release MRI EVO'17.0

TABLE 103
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

8.1.1.5 GSPS Modules

TABLE 104
PRESENTATION STATE IDENTIFICATION MODULE OF GSPS CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Presentation Creation Date	(0070,0082)	DA	<yyyymmdd>	ALWAYS	AUTO
Presentation Creation Time	(0070,0083)	TM	<hhmmss>	ALWAYS	AUTO
Instance Number	(0020,0013)	IS	Generated by device.	ALWAYS	AUTO
Content Label	(0070,0080)	CS	<i>ESAOTE_PRESENT.</i>	ALWAYS	AUTO
Content Description	(0070,0081)	LO		VNAP	AUTO
Content Creator's Name	(0070,0084)	PN		VNAP	AUTO

TABLE 105
PRESENTATION STATE RELATIONSHIP MODULE OF GSPS CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Referenced Series Sequence	(0008,1115)	SQ	Generated by device.	ALWAYS	AUTO
>Series Instance UID	(0020,000E)	UI	Generated by device.	ALWAYS	AUTO
>Referenced Image Sequence	(0008,1140)	SQ	Generated by device.	ALWAYS	AUTO
>>Referenced SOP Class UID	(0008,1150)	UI	Generated by device.	ALWAYS	AUTO
>>Referenced SOP Instance UID	(0008,1155)	UI	Generated by device.	ALWAYS	AUTO

TABLE 106
DISPLAY SHUTTER MODULE OF GSPS CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Shutter Shape	(0018,1600)	CS	RECTANGULAR, CIRCULAR or POLYGONAL.	ANAP	USER
Shutter Left Vertical Edge	(0018,1602)	IS	From user input.	ANAP	USER
Shutter Right Vertical Edge	(0018,1604)	IS	From user input.	ANAP	USER
Shutter Upper Horizontal Edge	(0018,1606)	IS	From user input.	ANAP	USER
Shutter Lower Horizontal Edge	(0018,1608)	IS	From user input.	ANAP	USER
Center of Circular Shutter	(0018,1610)	IS	From user input.	ANAP	USER
Radius of Circular Shutter	(0018,1612)	IS	From user input.	ANAP	USER
Vertices of the Polygonal Shutter	(0018,1629)	IS	From user input.	ANAP	USER
Shutter Presentation Value	(0018,1622)	US	0.	ALWAYS	AUTO

TABLE 107
DISPLAYED AREA MODULE OF GSPS CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Displayed Area Selection Sequence	(0070,005A)	SQ	From user input.	ALWAYS	USER
>Displayed Area Top Left Hand Corner	(0070,0052)	SL	From user input.	ALWAYS	USER
>Displayed Area Bottom Right Hand Corner	(0070,0053)	SL	From user input.	ALWAYS	USER
>Presentation Size Mode	(0070,0100)	CS	SCALE TO FIT or MAGNIFY	ALWAYS	USER
>Presentation Pixel Spacing	(0070,0101)	DS	Generated by device.	ALWAYS	COPY
>Presentation Pixel Magnification Ratio	(0070,0103)	FL	Present only if Presentation Size Mode equal to MAGNIFY	ANAP	USER

TABLE 108
GRAPHIC ANNOTATION MODULE OF GSPS CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value	Source
Graphic Annotation Sequence	(0070,0001)	SQ	From user input.	ALWAYS	USER
>Referenced Image Sequence	(0008,1140)	SQ	From user input.	ALWAYS	USER
>>Referenced SOP Class UID	(0008,1150)	UI	From user input.	ALWAYS	USER

>>Referenced SOP Instance UID	(0008,1155)	UI	From user input.	ALWAYS	USER
>Graphic Layer	(0070,0002)	CS	Generated by device.	ALWAYS	AUTO
>Text Object Sequence	(0070,0008)	SQ	From user input.	ANAP	USER
>>Bounding Box Annotation Units	(0070,0003)	CS	<i>PIXEL</i>	ALWAYS	AUTO
>>Unformatted Text Value	(0070,0006)	ST	From user input.	ALWAYS	USER
>>Bounding Box Top Left Hand Corner	(0070,0010)	FL	From user input.	ALWAYS	USER
>>Bounding Box Bottom Right Hand Corner	(0070,0011)	FL	From user input.	ALWAYS	USER
>>Bounding Box Text Horizontal Justification	(0070,0012)	CS	<i>LEFT</i>	ALWAYS	AUTO
>Graphic Object Sequence	(0070,0009)	SQ	From user input.	ANAP	USER
>>Graphic Annotation Units	(0070,0005)	CS	<i>PIXEL</i>	ALWAYS	AUTO
>>Graphic Dimensions	(0070,0020)	US	From user input.	ALWAYS	USER
>>Number of Graphic Points	(0070,0021)	US	From user input.	ALWAYS	USER
>>Graphic Data	(0070,0022)	FL	From user input.	ALWAYS	USER
>>Graphic Type	(0070,0023)	CS	From user input.	ALWAYS	USER
>>Graphic Filled	(0070,0024)	CS	From user input.	ALWAYS	AUTO

**TABLE 109
SPATIAL TRANSFORMATION MODULE OF GSPS CREATED SOP INSTANCES**

Attribute Name	Tag	VR	Value	Presence of Value	Source
Image Rotation	(0070,0042)	US	From user input.	ALWAYS	USER
Image Horizontal Flip	(0070,0041)	CS	From user input.	ALWAYS	USER

**TABLE 110
GRAPHIC LAYER MODULE OF GSPS CREATED SOP INSTANCES**

Attribute Name	Tag	VR	Value	Presence of Value	Source
Graphic Layer Sequence	(0070,0060)	SQ	Generated by device.	ALWAYS	AUTO
>Graphic Layer	(0070,0002)	CS	Generated by device.	ALWAYS	AUTO
>Graphic Layer Order	(0070,0062)	IS	Generated by device.	ALWAYS	AUTO

**TABLE 111
SOFTCOPY VOI LUT MODULE OF GSPS CREATED SOP INSTANCES**

Attribute Name	Tag	VR	Value	Presence of Value	Source
Softcopy VOI LUT Sequence	(0028,3110)	SQ	Generated by device.	ALWAYS	AUTO
>Referenced Image Sequence	(0008,1140)	SQ	Generated by device.	ALWAYS	AUTO

>>Referenced SOP Class UID	(0008,1150)	UI	Generated by device.	ALWAYS	AUTO
>>Referenced SOP Instance UID	(0008,1155)	UI	Generated by device.	ALWAYS	AUTO
>Window Center	(0028,1050)	DS	Generated by device.	ALWAYS	AUTO
>Window Width	(0028,1051)	DS	Generated by device.	ALWAYS	AUTO

**TABLE 112
SOFTCOPY PRESENTATION LUT MODULE OF GSPS CREATED SOP INSTANCES**

Attribute Name	Tag	VR	Value	Presence of Value	Source
Presentation LUT Shape	(2050,0020)	CS	<i>IDENTITY</i> or <i>INVERSION</i> .	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 and Grayscale Softcopy Presentation State 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 4.2.5.4.1.3.

8.1.3 Attribute mapping

The relationships between attributes received via Modality Worklist, stored in acquired images, are summarized in Table 113. The format and conventions used in it are the same as the corresponding table in DICOM Part 4, Annex M.6.

**TABLE 113
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	>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
----	Performed Procedure Step ID
Study Date ²⁸	Performed Procedure Step Start Date
Study Time ²⁹	Performed Procedure Step Start Time
Study Description ³⁰	Performed Procedure Step Description
Requested Procedure Code Sequence	Procedure Code Sequence ³¹
----	Referenced Performed Procedure Step Sequence
----	>Referenced SOP Class UID
----	>Referenced SOP Instance UID
----	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.

TABLE 114
MEANING OF THE RECEIVE COIL NAME CONTENTS

Receive Coil Name (0018,1250)	G-scan / S-scan / G-scan Brio	Magnifico Open / Magnifico MSK	Magnifico Vet	Vet-MR Grande / G-scan Vet / G-scan equine	O-scan / O-scan Equine
0	Coil 1	Linear Shoulder	Spine	Coil 1	Coil 1
1	Coil 2	Knee	Head	Coil 2	Coil 2
2	Coil 3	Hand/Wrist	Small Parts	Coil 3	Coil 3
3	Coil 4	Foot/Ankle	Small Head	Coil 4	===
4	===	===	===	===	===
5	Coil 6	===	===	Coil 6	===
6	Coil 7	===	===	Coil 7	===
7	Coil 8 (high position)	===	===	Coil 8 (high position)	===
8	Coil 8 (low position)	===	===	Coil 8 (low position)	===
9	Coil 9	===	===	Coil 9	===
10	===	===	===	===	===
11	===	===	===	===	===
12	Coil 10 (high	===	===	Coil 10 (high	===

²⁸ These attributes are not received from the worklist, but automatically generated by the machine.

²⁹ These attributes are not received from the worklist, but automatically generated by the machine.

³⁰ This attribute is not received from the worklist, but can be filled by the user.

³¹ Absent if empty in MWL or performed acquisition is different to what was scheduled.

	position)			position)	
13	Coil 10 (low position)	===	===	Coil 10 (low position)	===
14	===	===	===	Coil 11	===
15	===	===	===	Coil 12	===
16	===	===	===	Coil 13	===
17 ³²	Coil 14	C-spine	4 ch. Open Spine	Coil 14	===
18 ³³	Coil 15	===	===	Coil 15	===
19 ³⁴	Coil 16	Head		Coil 16	===
20 ³⁵	Coil 17	L-spine Small	4 ch. Large Spine	Coil 17	===
21 ³⁶	Coil 18	L-spine Large	===	Coil 18	===
22 ³⁸	Coil 19	TMJ	TMJ	===	===
23 ³⁸	Coil 20	MC Shoulder	===	===	===
24 ³⁸	Coil 99	===	===	===	===

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.

TABLE 115
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
(0011,1004)	Mean Image Noise	DS	1
(0011,1005)	Patient Vet Name (only used for ESAOTE MR veterinary systems)	LT	1
(0011,1006)	Patient Vet Species (only used for ESAOTE MR veterinary systems)	LT	1
(0011,1007)	Patient Vet Breed (only used for ESAOTE MR veterinary systems)	LT	1
(0011,1008)	Receiving Bandwidth ³⁷	DS	1
(0011,1009)	Diffusion b-value ³⁸	IS	1

³² Since the software release 1.2A E-MRI Bro.

³³ Since the software release 1.2B E-MRI Bro.

³⁴ Since the software release 1.3A E-MRI Bro.

³⁵ Since the software release 1.2B E-MRI Bro.

³⁶ Since the software release 1.2B E-MRI Bro.

³⁷ Since the software release MRI EVO'17.0

³⁸ Since the software release MRI EVO'21.0

(0011,100A)	Diffusion derivation ³⁸ (Possible values: SELECTION, READOUT and ENCODING)	CS	1
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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 EXTENDED / 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 ESAOTE MR VETERINARY IMAGES

The following paragraphs show the differences in the meaning and contents of the DICOM attributes between the images produced by the ESAOTE MR veterinary software releases and those produced by the other software releases.

For the attributes that are not described in this Annex there is no difference between the ESAOTE MR veterinary software releases 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.

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 ESAOTE MR veterinary models.

TABLE 116
GENERAL SERIES MODULE OF CREATED MR SOP INSTANCES
SPECIALIZATION FOR THE ESAOTE MR VETERINARY SYSTEMS

Attribute Name	Tag	VR	Value	Presence of Value	Source
Body Part Examined	(0018,0015)	CS	From the Patient Registration: <i>ELBOW, SHOULDER, HIP</i> (defined terms), <i>NEUROCRANIUM, SPLANCHNOCRANIUM, CERVICAL, CERVICO_THORACIC, LUMBO_SACRAL, THORACO_LUMBAR, STIFLE, CARPUS, PAW_A, PAW_P, HOCK, FETLOCK_A, FETLOCK_P, PASTERN_A, PASTERN_P, HOOV_P, HOOV_A</i> and <i>OTHER</i> (implementation-defined terms). 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 added to the Private Application Module (Table 97) for the ESAOTE MR veterinary software releases. Please note that the Private Creator is the same as in that table, and these attributes are present only in the ESAOTE MR veterinary systems.

TABLE 117
PRIVATE APPLICATION MODULE OF CREATED MR SOP INSTANCES
SPECIALIZATION FOR THE ESAOTE MR VETERINARY SYSTEMS

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 <i>DOG, CAT, HORSE</i> or <i>OTHER</i> (implementation-defined terms).	ALWAYS	USER
Patient Vet Breed	(0011,1007)	LT	From the Patient Registration: breed of the animal. Maximum 64 characters.	VNAP	USER