Leonardo Medical Tools

DICOM Conformance Statement

Version: 1.0.0

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Preface

Leonardo Medical Tools (LMT) is a set of applications that implement the DICOM standard and are compliant with IHE (Integrating the Healthcare Enterprise). These applications are developed to work independently as well as fully integrated into a complex medical software system which is able to satisfy all the radiology workflows. LMT is constituted by the following modules:

1. Leonardo Patient Store: Radiology Information System with modality worklist capabilities
2. Leonardo PACS: DICOM archive
3. Leonardo Web: Web-enabled DICOM workstation and viewer
4. Leonardo Viewer: Distributable DICOM viewer
5. Leonardo Bridge: Automated disc publishing module

LMT system offer various capabilities such as:

- Patient scheduling
- Storage and Retrieving of various kinds of DICOM objects
- Reporting
- DICOM image presentation
- Modality worklists
- Automated disc publishing

Each module has its own user friendly interface that allow administrators to configure multiple system parameters and business users develop their tasks in a fast and secure fashion.

1. LMT v 1.0.x

DICOM Conformance Statement

1.1. Overview

Leonardo Medical Tools (LMT) is a system that provides services for safe storage and retrieve of DICOM evidence object such Images, Key Image Notes, Presentation States, Structured Reports and others.

LMT supports the following IHE Integration Profiles:

- Access to Radiology Information (ARI)

- Consistent Presentation of Images (CPI)

- Evidence Documents (ED)

- Key Image Note (KIN)

- Scheduled Workflow (SWF)

LMT supports the following network services:

Table 1.1. NETWORK SERVICES

Networking SOP Classes	**User of Service (SCU)**	**Provider of Service (SCP)**
Transfer		
US Image Storage	Yes	Yes
US Multi-frame Storage	Yes	Yes
Computed Radiography Image Storage	Yes	Yes
Digital X-Ray Image Storage - For Presentation	Yes	Yes
Digital X-Ray Image Storage - For Processing	Yes	Yes
Digital Mammography X-Ray Image Storage - For Presentation	Yes	Yes
Digital Mammography X-Ray Image Storage - For Preprocessing	Yes	Yes
Digital Intra-oral X-Ray Image Storage - For Presentation	Yes	Yes
Digital Intra-oral X-Ray Image Storage - For Processing	Yes	Yes
CT Image Storage	Yes	Yes

Networking SOP Classes	**User of Service (SCU)**	**Provider of Service (SCP)**
MR Image Storage	Yes	Yes
Enhanced MR Image Storage	Yes	Yes
Secondary Capture Image Storage	Yes	Yes
X-Ray Angiographic Image Storage	Yes	Yes
X-Ray Radio fluoroscopic Image Storage	Yes	Yes
Nuclear Medicine Image Storage	Yes	Yes
VL Endoscopic Image Storage	Yes	Yes
VL Microscopic Image Storage	Yes	Yes
VL Slide-Coordinates Microscopic Image Storage	Yes	Yes
VL Photographic Image Storage	Yes	Yes
Positron Emission Tomography Image Storage	Yes	Yes
RT Image Storage	Yes	Yes
Raw Data Storage	Yes	Yes
Multi-frame Grayscale Byte Secondary Capture Image Storage	Yes	Yes
Multi-frame Grayscale Word Secondary Capture Image Storage	Yes	Yes
Multi-frame Color Secondary Capture Image Storage	Yes	Yes
Grayscale Softcopy Presentation State Storage	Yes	Yes
Hardcopy Grayscale Image Storage SOP Class	Yes	Yes
Hardcopy Color Image Storage SOP Class	Yes	Yes
Basic Text SR	Yes	Yes
Enhanced SR	Yes	Yes
Comprehensive SR	Yes	Yes
Key Object Selection Document	Yes	Yes
Storage Commitment Push Model	No	Yes
Workflow Management		
Modality Worklist - FIND	No	Yes
Modality Performed Procedure Step	No	No
Instance Availability Notification	No	No
Basic Study Content Notification	No	No
Query/Retrieve		
Patient Root Q/R - FIND	Yes	Yes

Networking SOP Classes	User of Service (SCU)	Provider of Service (SCP)
Patient Root Q/R - MOVE	Yes	Yes
Study Root Q/R - FIND	Yes	Yes
Study Root Q/R - MOVE	Yes	Yes
Patient/Study Only Q/R - FIND	Yes	Yes
Patient/Study Only Q/R - MOVE	Yes	Yes
Connectivity Verification		
Verification	Yes	Yes

1.2. Introduction

1.2.1. Revision History

Revision History:

Initial draft	Mar 2015	
Revision 0.1	Feb 2016	Network SOP classes
Revision 0.2	Dec 2016	Added MWL info
Revision 1.0	Aug 2017	Distributable

1.2.2. Audience

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

1.2.3. Remarks

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

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

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

The user should be aware of the following important issues:

- The comparison of different conformance statements is the first step towards assessing interconnectivity between Leonardo and non-Leonardo equipment.
- Test procedures should be defined to validate the desired level of connectivity.
- The DICOM standard will evolve to meet the users' future requirements. Leonardo is actively involved in developing the standard further and therefore reserves the right to make changes to its products or to discontinue its delivery.

1.2.4. Definitions, Terms and Abbreviations

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

Abbreviations and terms are as follows:

AE
DICOM Application Entity

AET
Application Entity Title

DICOM
Digital Imaging and Communications in Medicine

DIMSE
DICOM Message Service Element

GSDF
Grayscale Standard Display Function

HIS/RIS
Hospital Information System / Radiology Information System.

IHE
Integrating the Healthcare Enterprise

IHE-TF
Integrating the Healthcare Enterprise Technical Framework

IAN
Instance Availability Notification

IOD
Information Object Definition

ISO
International Standard Organization

PDU
DICOM Protocol Data Unit

LUT
Look-up Table

MPPS
Modality Performed Procedure Step

MWL
Modality Worklist

P-LUT
Presentation Look-up Table

Q/R
Query Retrieve

SCP
Service Class Provider

SCU
Service Class User

SCN
Study Content Notification

SOP
DICOM Service-Object Pair

TCP/IP
Transmission Control Protocol/Internet Protocol

TLS
Transport Layer Security

UID
Unique Identifier

VR
Value Representation

1.2.5. References

[DICOM]
Digital Imaging and Communications in Medicine (DICOM), NEMA PS 3.1- 3.16, 2001

[IHE-TF]
Integrating the Healthcare Enterprise Technical Framework, HIMSS/RSNA, Revision 5.4, 2002

1.3. Networking

1.3.1. Implementation Model

1.3.1.1. Application Data Flow

LMT is logically divided in four different DICOM Application Entities: Storage Server, Query/Retrieve Server, Modality Worklist Server and Disc Publishing Server.

The Application Entities are all Java Enterprise Application and are designed to run in a J2EE compliant container (i.e. Glassfish) on any Java Virtual Machine 1.5+ capable Operating System.

The Storage Server AE implements the DICOM Storage Service Class and Verification Service Class.

The Query/Retrieve Server AE implements Query/Retrieve Services.

The Modality Worklist Server AE implements the Verification Service Class and the Basic Worklist Management Service Class.

The Disc Publishing manager AE implements the DICOM Storage Service Class.

1.3.1.2. Functional Definition of AEs

1.3.1.2.1. Functional Definition of LMT Storage Server Application Entity

The LMT Storage Server Application Entity waits for another application to connect at the presentation address configured for its Application Entity Title. When another application connects, the STORAGE-SCP AE expects it to be a DICOM application.

The STORAGE-SCP AE will accept Associations with Presentation Contexts for SOP Classes of the Verification, Storage, and Storage Commitment Service Classes.

DICOM Instances received in a Storage Request are filed on local (attached/mounted) file system(s). A subset of attributes from received Instances is also stored in records of a local database.

1.3.1.2.2. Functional Definition of LMT Query/Retrieve Server Application Entity

The LMT Query/Retrieve Server Application Entity waits for another application to connect at the presentation address configured for its Application Entity Title. When another application connects, the Storage Server AE expects it to be a DICOM application.

The Query/Retrieve Server AE will accept Associations with Presentation Contexts for SOP Classes of the Verification and Query/Retrieve Service Classes.

Once received a Retrieve (Move) request, Query/Retrieve Server AE will initiate a new association and send the requested instances to the Move Destination AE.

1.3.1.2.3. Functional Definition of LMT Modality Worklist Server Application Entity

The LMT Modality Worklist Server Application Entity waits for another application to connect at the presentation address configured for its Application Entity Title. When another application connects, the Modality Worklist Server AE expects it to be a DICOM application.

The Modality Worklist Server AE will accept Associations with Presentation Contexts for SOP Classes of the Verification and Modality Worklist Service Classes.

When a Modality Worklist Find request is received, Modality Worklist Server AE will query the local database for a list of Scheduled Procedure Steps matching the query and will return a pending C-Find response for each match.

Before patient and order information can be included in response to a Modality Worklist query, Modality Worklist items must be created by the LMT/RIS operator.

1.3.1.2.4. Functional Definition of LMT Disc Publishing Server Application Entity

The LMT Disc Publishing Server Application Entity waits for another application to connect at the presentation address configured for its Application Entity Title. When another application connects, the Disc Publishing AE expects it to be a DICOM application.

The Disc Publishing AE will accept Associations with Presentation Contexts for SOP Classes of the Verification and Storage Service Classes.

The Disc publishing stores the received instances on the local file system temporary and then will forward them to configured disc publishing equipment.

Note: LMT Disc Publishing Server will not have a separate AE specification further in this document as it's the same as for LMT Storage Server AE.

1.3.2. AE Specifications

1.3.2.1. LMT Storage Server Application Entity Specification

1.3.2.1.1. SOP Classes

LMT Storage Server Application Entity provides Standard Conformance to the following SOP Classes:

Table 1.2. SOP Classes for LMT Storage Server AE

SOP Class Name	SOP Class UID	SCU	SCP
Verification SOP Class	1.2.840.10008.1.1	Yes	Yes
Storage Commitment Push Model SOP Class	1.2.840.10008.1.20.1	No	No
Hardcopy Grayscale Image Storage SOP Class	1.2.840.10008.5.1.1.29	No	Yes
Hardcopy Color Image Storage SOP Class	1.2.840.10008.5.1.1.30	No	Yes
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	No	Yes
Digital X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.1	No	Yes
Digital X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.1.1	No	Yes
Digital Mammography X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.2	No	Yes
Digital Mammography X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.2.1	No	Yes
Digital Intra-oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.3	No	Yes
Digital Intra-oral X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.3.1	No	Yes
CT Image Storage	1.2.840.10008.5.1.4.1.1.2.2	No	Yes
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	No	Yes
MR Image Storage	1.2.840.10008.5.1.4.1.1.4.4	No	Yes
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1	No	Yes
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	No	Yes
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	No	Yes

SOP Class Name	SOP Class UID	SCU	SCP
Multi-frame Grayscale Byte Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.2	No	Yes
Multi-frame Grayscale Word Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.3	No	Yes
Multi-frame Color Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.4	No	Yes
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	No	Yes
X-Ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2	No	Yes
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	No	Yes
Raw Data Storage	1.2.840.10008.5.1.4.1.1.66	No	Yes
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	No	Yes
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2	No	Yes
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3	No	Yes
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4	No	Yes
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	No	Yes
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	No	Yes
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1	No	Yes
Basic Text SR	1.2.840.10008.5.1.4.1.1.88.11	No	Yes
Enhanced SR	1.2.840.10008.5.1.4.1.1.88.22	No	Yes
Comprehensive SR	1.2.840.10008.5.1.4.1.1.88.33	No	Yes
Key Object Selection Document	1.2.840.10008.5.1.4.1.1.88.59	No	Yes

1.3.2.1.2. Association Establishment Policy

1.3.2.1.2.1. General

The LMT Storage Server AE can both accept and propose Association Requests. The LMT Storage Server AE will accept Association Requests for the Verification and Storage Services.

1.3.2.1.2.2. Number of Associations

LMT Storage Server can support multiple simultaneous Associations requested by peer AEs. Default is 10.

Table 1.3. Number of Associations accepted for LMT Storage Server AE

Maximum number of simultaneous Associations	10 (Configurable)

1.3.2.1.2.3. Asynchronous Nature

LMT Storage Server does not support asynchronous communication. Multiple outstanding transactions are not supported. It allows up to one invoked and one performed operation on an Association (it is synchronous). Asynchronous mode of operation is not supported.

Table 1.4. Asynchronous Nature as SCP for LMT Storage Server AE

Maximum number of outstanding asynchronous transactions	1 (Not Configurable)

1.3.2.1.3. Association Acceptance Policy

1.3.2.1.3.1. Activity - Receive Images

1.3.2.1.3.1.1. Description and Sequencing of Activities

A remote peer DICOM Application Entity, acting as a Storage SCU, establishes an association with LMT Storage Server that accepts these Associations for the purpose of receiving supported SOP Class Instances.

In the default configuration any Calling and Called AET will be accepted. But the Called AET does not correspond to the actual Storage Server AET, only a Presentation Context for the Verification SOP Class will be accepted and the SCU can only verify the DICOM Association, but cannot invoke any other related DICOM service.

The Storage Server AE may reject Association attempts as shown in the table below. The Result, Source and Reason columns represent the values returned in the corresponding fields of an ASSOCIATE-RJ PDU (see PS 3.8, Section 9.3.4).

Table 1.5. Association Rejection Reasons

Result	Source	Reason	Description
2 – rejected transient	provider	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.
1 – rejected permanent	user	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	user	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.

1.3.2.1.3.1.2. Accepted Presentation Contexts

Table 1.6. Accepted Presentation Contexts for LMT Storage Server AE

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
		VR Little Endian			
Storage Commitment Push Model	1.2.840.10008.1.20.1	Transfer Syntaxes for Non-Image Storage Services		SCP	None
Hardcopy Grayscale Image Storage SOP Class	1.2.840.10008.5.1.1.29	Transfer Syntaxes for Image Storage Services		SCP	None
Hardcopy Color Image Storage SOP Class	1.2.840.10008.5.1.1.30	Transfer Syntaxes for Image Storage Services		SCP	None
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	Transfer Syntaxes for Image Storage Services		SCP	None

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Digital X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.1	Transfer Syntaxes for Image Storage Services		SCP	None
Digital Mammography X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.2	Transfer Syntaxes for Image Storage Services		SCP	None
Digital Mammography X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.2.1	Transfer Syntaxes for Image Storage Services		SCP	None
Digital Intra-oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.3	Transfer Syntaxes for Image Storage Services		SCP	None
Digital Intra-oral X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.3.1	Transfer Syntaxes for Image Storage Services		SCP	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Transfer Syntaxes for Image Storage Services		SCP	None
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	Transfer Syntaxes for Image Storage Services		SCP	None
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Transfer Syntaxes for Image Storage Services		SCP	None
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1	Transfer Syntaxes for Image Storage Services		SCP	None
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	Transfer Syntaxes for Image Storage Services		SCP	None
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	Transfer Syntaxes for Image Storage Services		SCP	None
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Transfer Syntaxes for Image Storage Services		SCP	None
X-Ray Radio fluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2	Transfer Syntaxes for Image Storage Services		SCP	None
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	Transfer Syntaxes for Image Storage Services		SCP	None
Raw Data Storage	1.2.840.10008.5.1.4.1.1.66	Transfer Syntaxes for Non-Image Storage Services		SCP	None
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	Transfer Syntaxes for Image Storage Services		SCP	None
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2	Transfer Syntaxes for Image Storage Services		SCP	None
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3	Transfer Syntaxes for Image Storage Services		SCP	None
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4	Transfer Syntaxes for Image Storage Services		SCP	None

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	Transfer Syntaxes for Image Storage Services		SCP	None
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	Transfer Syntaxes for Image Storage Services		SCP	None
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1	Transfer Syntaxes for Non-Image Storage Services		SCP	None
Basic Text SR	1.2.840.10008.5.1.4.1.1.88.11	Transfer Syntaxes for Non-Image Storage Services		SCP	None
Enhanced SR	1.2.840.10008.5.1.4.1.1.88.22	Transfer Syntaxes for Non-Image Storage Services		SCP	None
Comprehensive SR	1.2.840.10008.5.1.4.1.1.88.33	Transfer Syntaxes for Non-Image Storage Services		SCP	None
Key Object Selection Document	1.2.840.10008.5.1.4.1.1.88.59	Transfer Syntaxes for Non-Image Storage Services		SCP	None

Table 1.7. Accepted Transfer Syntaxes for Non-Image Storage Services

Name	UID
Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1

Table 1.8. Accepted Transfer Syntaxes for Image Storage Services

Name	UID
Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1
JPEG Baseline	1.2.840.10008.1.2.4.50
JPEG Extended	1.2.840.10008.1.2.4.51
JPEG Lossless, Non-Hierarchical	1.2.840.10008.1.2.4.57
JPEG Lossless, Non-Hierarchical, First-Order Prediction	1.2.840.10008.1.2.4.70
JPEG-LS Lossless Image Compression	1.2.840.10008.1.2.4.80
JPEG-LS Lossy (Near-Lossless) Image	1.2.840.10008.1.2.4.81
JPEG 2000 Image Compression (Lossless Only)	1.2.840.10008.1.2.4.90
JPEG 2000 Image Compression	1.2.840.10008.1.2.4.91

If the Called AET is not corresponding to the actual Storage Server AET, it only will be accepted the Presentation Context for the Verification SOP Class.

1.3.2.1.3.1.3. SOP Specific Conformance

1.3.2.1.3.1.3.1. Specific Conformance for Verification SOP Class

LMT Storage Server provides standard conformance to the DICOM Verification Service Class as a SCP. The status code for the C-ECHO is described in the following table:

Table 1.9. C-Echo Response Status Handling Behavior

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

1.3.2.1.3.1.3.2. Specific Conformance for Storage SOP Classes

The associated Activity with the Storage service is the storage of medical DICOM data received over the network on a designated storage repository. The LMT Storage Server AE will return a failure status if it is unable to store the received instance(s).

The LMT Storage Server AE does not have any dependencies on the number of Associations used to send images to it. Images belonging to more than one Study or Series can be sent over a single or multiple Associations. Images belonging to a single Study or Series can also be sent over different Associations. There is no limit on either the number of SOP Instances or the maximum amount of total SOP Instance data that can be transferred over a single Association.

The LMT Storage Server AE is configured to retain the original DICOM data in DICOM Part 10 compliant file format. The LMT Storage Server AE is Level 2 (Full) conformant as a Storage SCP. In addition, all Private and SOP Class Extended Elements are maintained in the DICOM format files. In addition to saving all Elements in files, a subset of the Elements are stored in the LMT Query/Retrieve Server database to support query and retrieval requests and also allow updating of Patient, Study, and Series information by user input, or demographic and Study related messages.

If the received instance is a duplicate of a previously received instance, the old file and database information will be overwritten with the new one.

The average throughput performance has been determined to be between 2 and 6 Mega Bytes per second on a 100 Megabit Ethernet network. Actual performance will depend greatly on the performance of the C-STORE SCU, the number of simultaneous active Associations, and the underlying network performance.

1.3.2.1.3.1.3.2.1. Storage Server AE C-STORE Response

Table 1.10. LMT Storage Server C-STORE Response Status

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The Composite SOP Instance was successfully received, verified, and stored in the system repository.
Error	Processing Failure	0110	This status is returned due to internal errors such as a processing failure response from the internal database or a filesystem operation. The appropriate Status will be sent in the C-STORE Response. Error indication message is output to the Service Log.
Warning	Coercion of Data Elements	B000	This status is returned if one or more Attribute values were coerced/modified on reception. Image transmission is considered successful. The appropriate SUCCESS Status will be sent in the C-STORE Response. Warning indication message is output to the Service Log.
Warning	Data Set does not match SOP class	B007	This status is returned if the C-STORE Request specifies Attributes that are not specific as part of the Storage SOP class. Image transmission is considered successful. The appropriate SUCCESS Status will be sent in the C-STORE Response. Warning indication message is output to the Service Log.

1.3.2.1.3.1.3.2.2. Storage Server AE Storage Service Communication Failure Reasons

Table 1.11. LMT Storage Server Service Communication Failure Reasons

Exception	Reason
Timeout expiry for an expected DICOM Message Request (DIMSE level timeout). I.e. The STORAGE-SCP AE is waiting for the next C-STORE Request on an open Association but the timer expires.	The Association is aborted by issuing a DICOM A-ABORT. Error message is output to the Service Log. If some Composite SOP Instances have already been successfully received then they are maintained in the database. They are not automatically discarded be-cause of a later failure.
Timeout expiry for an expected DICOM PDU or TCP/IP packet (Low-level timeout). I.e. The STORAGE-SCP AE is waiting for the next C-STORE Data Set PDU but the timer expires.	The Association is aborted by issuing a DICOM A-ABORT. Error message is output to the Service Log. If a C-STORE Data Set has not been fully received then the data already received is discarded. If some Composite SOP Instances have already been successfully received over the Association then they are maintained in the database.
Association aborted by the SCU or the network layers indicate communication loss (i.e. low-level TCP/IP socket closure)	Error message is output to the Service Log. If some Composite SOP Instances have already been successfully received then they are maintained in the database. They are not automatically discarded because of a later failure.

1.3.2.2. LMT Query/Retrieve Server Application Entity Specification

1.3.2.2.1. SOP Classes

LMT Query/Retrieve Server Application Entity provides Standard Conformance to the following SOP Classes:

Table 1.12. SOP Classes for LMT Query/Retrieve Server AE

SOP Class Name	SOP Class UID	SCU	SCP
Verification SOP Class	1.2.840.10008.1.1	Yes	Yes
Patient Root Q/R Information Model - FIND	1.2.840.10008.5.1.4.1.2.1.1	No	Yes
Patient Root Q/R Information Model - MOVE	1.2.840.10008.5.1.4.1.2.1.2	No	Yes
Study Root Q/R Information Model - FIND	1.2.840.10008.5.1.4.1.2.2.1	No	Yes
Study Root Q/R Information Model - MOVE	1.2.840.10008.5.1.4.1.2.2.2	No	Yes
Patient/Study Only Q/R Information Model - FIND	1.2.840.10008.5.1.4.1.2.3.1	No	Yes
Patient/Study Only Q/R Information Model - MOVE	1.2.840.10008.5.1.4.1.2.3.2	No	Yes
Hardcopy Grayscale Image Storage SOP Class	1.2.840.10008.5.1.1.29	Yes	No
Hardcopy Color Image Storage SOP Class	1.2.840.10008.5.1.1.30	Yes	No
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	Yes	No
Digital X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.1	Yes	No

SOP Class Name	SOP Class UID	SCU	SCP
Digital X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.1	Yes	No
Digital Mammography X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.2	Yes	No
Digital Mammography X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.2.1	Yes	No
Digital Intra-oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.3	Yes	No
Digital Intra-oral X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.3.1	Yes	No
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Yes	No
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	Yes	No
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Yes	No
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1	Yes	No
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	Yes	No
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	Yes	No
Multi-frame Grayscale Byte Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.2	Yes	No
Multi-frame Grayscale Word Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.3	Yes	No
Multi-frame Color Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.4	Yes	No
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Yes	No
X-Ray Radio fluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2	Yes	No
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	Yes	No
Raw Data Storage	1.2.840.10008.5.1.4.1.1.66	Yes	No
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	Yes	No

SOP Class Name	SOP Class UID	SCU	SCP
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3	Yes	No
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4	Yes	No
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	Yes	No
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	Yes	No
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1	Yes	No
Basic Text SR	1.2.840.10008.5.1.4.1.1.88.11	Yes	No
Enhanced SR	1.2.840.10008.5.1.4.1.1.88.22	Yes	No
Comprehensive SR	1.2.840.10008.5.1.4.1.1.88.33	Yes	No
Key Object Selection Document	1.2.840.10008.5.1.4.1.1.88.59	Yes	No

1.3.2.2.2. Association Establishment Policy

1.3.2.2.2.1. General

The LMT Query/Retrieve Server AE can both accept and propose Association Requests. The Query/Retrieve Server AE will accept Association Requests for the Verification and Query/Retrieve Services. It will propose Associations for Verification and Storage Services.

1.3.2.2.2.2. Number of Associations

LMT Query/Retrieve Server can support multiple simultaneous Associations requested by peer AEs.

Table 1.13. Number of Associations accepted for LMT Query/Retrieve Server AE

Maximum number of simultaneous Associations	10 (Configurable)

1.3.2.2.2.3. Asynchronous Nature

LMT Query/Retrieve Server does not support asynchronous communication. Multiple outstanding transactions are not supported. It allows up to one invoked and one performed operation on an Association (it is synchronous). Asynchronous mode of operation is not supported.

Table 1.14. Asynchronous Nature as SCP for LMT Query/Retrieve Server AE

Maximum number of outstanding asynchronous transactions	1 (Not Configurable)

1.3.2.2.3. Association Initiation Policy

1.3.2.2.3.1. Activity - Send Images Requested by an External Peer AE

1.3.2.2.3.1.1. Description and Sequencing of Activities

The LMT Query/Retrieve Server AE will initiate a new Association when a valid C-MOVE Request has been performed by an external Peer. The Query/Retrieve Server AE will send the Association Request to the specific C-MOVE destination, and upon successful negotiation of the required Presentation Context the image transfer is started. In all cases an attempt will be made to transmit all the indicated images in a single Association but this may not always be possible. The Association will be released when all the images have been sent.

If an error occurs during transmission over an open Association then the image transfer is halted. The Query/ Retrieve Server AE will not attempt to independently retry the image export.

1.3.2.2.3.1.1.1. Proposed Presentation Contexts

LMT Query/Retrieve Server will propose Presentation Contexts as shown in the following table:

Table 1.15. Proposed Presentation Contexts by the LMT Query/Retrieve Server AE

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Hardcopy Grayscale Image Storage SOP Class	1.2.840.10008.5.1.1.29	Transfer Syntaxes for Image Storage Services		SCU	None

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Hardcopy Color Image Storage SOP Class	1.2.840.10008.5.1.1.30	Transfer Syntaxes for Image Storage Services		SCU	None
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	Transfer Syntaxes for Image Storage Services		SCU	None
Digital X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.1	Transfer Syntaxes for Image Storage Services		SCU	None
Digital X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.1.1	Transfer Syntaxes for Image Storage Services		SCU	None
Digital Mammography X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.2	Transfer Syntaxes for Image Storage Services		SCU	None
Digital Mammography X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.2.1	Transfer Syntaxes for Image Storage Services		SCU	None
Digital Intra-oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.3	Transfer Syntaxes for Image Storage Services		SCU	None
Digital Intra-oral X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.3.1	Transfer Syntaxes for Image Storage Services		SCU	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Transfer Syntaxes for Image Storage Services		SCU	None
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	Transfer Syntaxes for Image Storage Services		SCU	None
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Transfer Syntaxes for Image Storage Services		SCU	None
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1	Transfer Syntaxes for Image Storage Services		SCU	None
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	Transfer Syntaxes for Image Storage Services		SCU	None
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	Transfer Syntaxes for Image Storage Services		SCU	None
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Transfer Syntaxes for Image Storage Services		SCU	None
X-Ray Radio fluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2	Transfer Syntaxes for Image Storage Services		SCU	None
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	Transfer Syntaxes for Image Storage Services		SCU	None
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	Transfer Syntaxes for Image Storage Services		SCU	None
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2	Transfer Syntaxes for Image Storage Services		SCU	None

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Image Storage	1.77.1.3	Storage Services			None
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4	Transfer Syntaxes for Image Storage Services		SCU	None
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	Transfer Syntaxes for Image Storage Services		SCU	None
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	Transfer Syntaxes for Image Storage Services		SCU	None
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1	Transfer Syntaxes for Non-Image Storage Services		SCU	None
Basic Text SR	1.2.840.10008.5.1.4.1.1.88.11	Transfer Syntaxes for Non-Image Storage Services		SCU	None
Enhanced SR	1.2.840.10008.5.1.4.1.1.88.22	Transfer Syntaxes for Non-Image Storage Services		SCU	None
Comprehensive SR	1.2.840.10008.5.1.4.1.1.88.33	Transfer Syntaxes for Non-Image Storage Services		SCU	None
Key Object Selection Document	1.2.840.10008.5.1.4.1.1.88.59	Transfer Syntaxes for Non-Image Storage Services		SCU	None

Table 1.16. Proposed Transfer Syntaxes for Non-Image Storage Services

Name	UID
Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1

Table 1.17. Proposed Transfer Syntaxes for Image Storage Services

Name	UID
Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1
JPEG Baseline	1.2.840.10008.1.2.4.50
JPEG Extended	1.2.840.10008.1.2.4.51
JPEG Lossless, Non-Hierarchical	1.2.840.10008.1.2.4.57
JPEG Lossless, Non-Hierarchical, First-Order Prediction	1.2.840.10008.1.2.4.70
JPEG-LS Lossless Image Compression	1.2.840.10008.1.2.4.80
JPEG-LS Lossy (Near-Lossless) Image	1.2.840.10008.1.2.4.81
JPEG 2000 Image Compression (Lossless Only)	1.2.840.10008.1.2.4.90

Name	UID
JPEG 2000 Image Compression	1.2.840.10008.1.2.4.91

1.3.2.2.3.1.1.1.1. SOP Specific Conformance

1.3.2.2.3.1.1.1.1.1. Specific Conformance for Image, SR, KIN and SPS SOP Classes

When a SOP Instance is selected for export from LMT Query/Retrieve Server, its contents will be exported as it was originally received unless some of the Patient demographic and Study information Elements were altered.

The Patient demographic and Study information can be entered or altered by several means: manually (through the user interface), or from RIS. The replacement behavior depends on which specific DICOM and RIS services are supported. Also, this behavior is configurable. Values can be altered without changing the SOP Instance UID unless otherwise noted.

The Query/Retrieve Server AE will exhibit the following behavior according to the Status Code value returned in a C-STORE Response from a destination C-STORE SCP:

Table 1.18. LMT Query/Retrieve Server AE C-STORE Response Status Handling Behavior

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The remote Storage SCP has successfully stored the exported SOP Instance. The appropriate PENDING or SUCCESS Status will be sent in the C-MOVE Response. Success indication message is output to the Service Log.
Refused	Out of Resources	A700-A7FF	This is treated as a permanent Failure. The appropriate Status will be sent in the C-MOVE Response. Error indication message is output to the Service Log.
Error	Cannot Under-stand	C000-CFFF	This is treated as a permanent Failure. The appropriate Status will be sent in the C-MOVE Response. Error indication message is output to the Service Log.
Warning	Coercion of Data Elements	B000	Image transmission is considered successful. The appropriate PENDING or SUCCESS Status will be sent in the C-MOVE Response. Success indication message is output to the Service Log.
Warning	Data Set does not match SOP class	B007	Image transmission is considered successful. The appropriate PENDING or SUCCESS Status will be sent in the C-MOVE Response. Success indication message is output to the Service Log.
Warning	Elements Dis-carded	B006	Image transmission is considered successful. The appropriate PENDING or SUCCESS Status will be sent in the C-MOVE Response. Success indication message is output to the Service Log.
Warning	Attribute List Error	0107	Image transmission is considered successful. The appropriate PENDING or SUCCESS Status will be sent in the C-MOVE Response. Success indication message is output to the Service Log.

Service Status	Further Meaning	Error Code	Behavior
Warning	Attribute Value Out of Range	0116	Image transmission is considered successful. The appropriate PENDING or SUCCESS Status will be sent in the C-MOVE Response. Success indication message is output to the Service Log.
*	*	Any other status code	This is treated as a permanent Failure. The appropriate Status will be sent in the C-MOVE Response. Error indication message is output to the Service Log.

Table 1.19. LMT Query/Retrieve Server AE Communication Failure Behavior

Exception	Behavior
Timeout expiry for an expected DICOM Message Request (DIMSE level timeout).	The Association is aborted by issuing a DICOM A-ABORT. The appropriate Status will be sent in the CMOVE Response. Error indication message is output to the Service Logs
Timeout expiry for an expected DICOM PDU or TCP/IP packet (Low-level timeout).	The Association is aborted by issuing a DICOM A-ABORT. The appropriate Status will be sent in the CMOVE Response. Error indication message is output to the Service Logs
Association A-ABORTed by the SCU or the network layers indicate communication loss (i.e. low-level TCP/IP socket closure).	The TCP/IP Socket is closed. Error indication message is output to the Service Logs

1.3.2.2.4. Association Acceptance Policy

1.3.2.2.4.1. Activity - Handling Query and Retrieval Requests

1.3.2.2.4.1.1. Description and Sequencing of Activities

The Query/Retrieve Server AE accepts Associations only if they have valid Presentation Contexts. If none of the requested Presentation Contexts are accepted then the Association Request itself is rejected. It can be configured to only accept Associations from certain Application Entities.

If Query/Retrieve Server AE receives a query (C-FIND) request then the response(s) will be sent over the same Association used to send the C-FIND-Request.

If Query/Retrieve Server AE receives a retrieval (C-MOVE) request then the responses will be sent over the same Association used to send the C-MOVE-Request.

The Query/Retrieve Server AE will send the requested SOP Instances to the C-MOVE Destination over a newly created Association and report in the C-MOVE-Response any success or failure status of each attempt to send a Composite SOP Instance.

The Query/Retrieve Server AE may reject Association attempts as shown in the table below. The Result, Source and Reason columns represent the values returned in the corresponding fields of an ASSO-CIATE-RJ PDU (see PS 3.8, Section 9.3.4).

Table 1.20. Association Rejection Reasons

Result	Source	Reason	Description
2 – rejected transient	provider	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.
1 – rejected permanent	user	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	user	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.

1.3.2.2.4.1.2. Accepted Presentation Contexts

Table 1.21. Accepted Presentation Contexts for LMT Query/Retrieve Server AE

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Verification SOP Class	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Patient Root Q/R Information Model – FIND	1.2.840.10008.5.1.4.1.2.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	Relational-queries
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
Patient Root Q/R Information Model – MOVE	1.2.840.10008.5.1.4.1.2.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	Relational-retrieve
		Explicit VR Little Endian	1.2.840.10008.1.2.1		

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Study Root Q/R Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	
		Explicit VR Little Endian	1.2.840.10008.1.2.1		Relational-queries
Study Root Q/R Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	
		Explicit VR Little Endian	1.2.840.10008.1.2.1		Relational-retrieve
Patient/Study Only Q/R Information Model – FIND	1.2.840.10008.5.1.4.1.2.3.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	
		Explicit VR Little Endian	1.2.840.10008.1.2.1		Relational-queries
Patient/Study Only Q/R Information Model – MOVE	1.2.840.10008.5.1.4.1.2.3.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	
		Explicit VR Little Endian	1.2.840.10008.1.2.1		Relational-retrieve

If the Called AET is not corresponding to the actual Storage Server AET, it only will be accepted the Presentation Context for the Verification SOP Class.

1.3.2.2.4.1.3. SOP Specific Conformance

1.3.2.2.4.1.3.1. Specific Conformance for Verification SOP Class

LMT Storage Server provides standard conformance to the DICOM Verification Service Class as a SCP. The status code for the C-ECHO is described in the following table:

Table 1.22. C-Echo Response Status Handling Behavior

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

1.3.2.2.4.1.3.2. Specific Conformance for Query SOP Classes

The Query/Retrieve Server AE supports hierarchical and relational queries. There are no attributes always returned by default. Only those attributes requested in the query identifier are returned.

Query responses always return values from the Query/Retrieve Server database. Exported SOP Instances are always updated with the latest values kept in the database prior to export. Thus, a change in Patient demographic information will be contained in both the C-FIND Responses and any Composite SOP Instances exported to a C-MOVE Destination AE.

Patient Root Information Model: All required search keys on each of the four levels (Patient, Study, Series, and Image) are supported. However, the Patient ID (0010, 0020) key must have at least a partial value if the Patient's Name (0010, 0010) is not present in a Patient Level query.

Study Root Information Model: All the required search keys on each of the three levels (Study, Series, and Image) are supported. If no partial values are specified for Study attributes then either the Patient ID (0010, 0020) key or the Patient's Name (0010, 0010) must have at least a partial value specified.

Patient/Study Only Information Model: All the required search keys on the Patient and Study levels are supported. The Patient ID (0010, 0020) key must be at least partially stated if the Patient's Name (0010, 0010) is not present in a Patient Level query.

Table 1.23. Patient Root C-FIND SCP Supported Elements

Attribute Name	Tag	VR	Types of Matching
SOP Common			
Specific Character Set	0008,0005	CS	NONE
Patient Level			
Patient's Name	0010,0010	PN	S,*,U
Patient ID	0010,0020	LO	S,*,U
Issuer of Patient ID	0010,0021	LO	NONE
Patient's Birth Date	0010,0030	DA	S,U,R
Patient's Sex	0010,0040	CS	S,*,U
Study Level			
Study Instance UID	0020,000D	UI	S,L
Study ID	0020,0010	SH	S,*,U
Study Date	0008,0020	DA	S,U,R
Study Time	0008,0030	TM	S,U,R
Accession Number	0008,0050	SH	S,*,U
Referring Physician's Name	0008,0090	PN	S,*,U
Modalities In Study	0008,0061	CS	S,*,U
Series Level			
Series Instance UID	0020,000E	UI	S,L

Attribute Name	Tag	VR	Types of Matching
Series Number	0020,0011	IS	S,*,U
Modality	0008,0060	CS	S,*,U
Performed Procedure Step Start Date	0040,0244	DA	S,U,R
Performed Procedure Step Start Time	0040,0245	TM	S,U,R
Image Level			
SOP Instance UID	0008,0018	UI	S,L
SOP Class UID	0008,0016	UI	S,L
Instance Number	0020,0013	IS	S,*,U
Completion Flag	0040,0A91	CS	S,*,U
Verification Flag	0040,0A93	CS	S,*,U

Table 1.24. Study Root C-FIND SCP Supported Elements

Attribute Name	Tag	VR	Types of Matching
SOP Common			
Specific Character Set	0008,0005	CS	NONE
Study Level			
Patient's Name	0010,0010	PN	S,*,U
Patient ID	0010,0020	LO	S,*,U
Issuer of Patient ID	0010,0021	LO	NONE
Patient's Birth Date	0010,0030	DA	S,U,R
Patient's Sex	0010,0040	CS	S,U
Study Instance UID	0020,000D	UI	S,L
Study ID	0020,0010	SH	S,*,U
Study Date	0008,0020	DA	S,U,R
Study Time	0008,0030	TM	S,U,R
Accession Number	0008,0050	SH	S,*,U
Referring Physician's Name	0008,0090	PN	S,*,U
Modalities In Study	0008,0061	CS	S,*,U
Series Level			
Series Instance UID	0020,000E	UI	S,L
Series Number	0020,0011	IS	S,*,U
Modality	0008,0060	CS	S,*,U

Attribute Name	Tag	VR	Types of Matching
Performed Procedure Step Start Date	0040,0244	DA	S,U,R
Performed Procedure Step Start Time	0040,0245	TM	S,U,R
Image Level			
SOP Instance UID	0008,0018	UI	S,L
SOP Class UID	0008,0016	UI	S,L
Instance Number	0020,0013	IS	S,*,U
Completion Flag	0040,0A91	CS	S,*,U
Verification Flag	0040,0A93	CS	S,*,U

Types of Matching:

The types of Matching supported by the C-FIND SCP. An "S" indicates the identifier attribute uses Single Value Matching, an “R” indicates Range Matching, an “*” indicates wildcard matching, a ‘U’ indicates Universal Matching, and an ‘L’ indicates that UID lists are supported for matching. “NONE” indicates that no matching is supported, but that values for this Element are requested to be returned (i.e. universal matching).

Table 1.25. LMT Query/Retrieve Server C-FIND Response Status

Service Status	Further meaning	Error Code	Behavior
Success	Success	0000	Matching is complete. No final identifier is supplied
Error	Processing Failure	0110	This status is returned due to internal errors such as a processing failure response on a query of the internal database. The appropriate Status will be sent in the C-FIND Response. Error indication message is output to the Service Log.
Cancel	Matching terminated due to Cancel Request	FE00	The C-FIND SCU sent a Cancel Request. This has been acknowledged and the search for matches has been halted. Cancel indication message is output to the Service Log.
Pending	Matches are continuing and current match is supplied	FF00	Indicates that the search for further matches is continuing. This is returned when each successful match is returned and when further matches are forthcoming. Pending indication message is output to the Service Log.

1.3.2.2.4.1.3.3. Specific Conformance for Query SOP Classes

Exported SOP Instances are always updated with the latest values kept in the database prior to export.

Table 1.26. LMT Query/Retrieve Server C-MOVE Response Status

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	Matching is complete. No final identifier is supplied
Error	Processing Failure	0110	This status is returned due to internal errors such as a processing failure response on a query of the internal database. The appropriate Status will be sent in the C-MOVE Response. Error indication message is output to the Service Log.
Error	Unable to perform sub-operations	A702	C-STORE sub-operations cannot be performed due to failure of an Association Request or a C-STORE Request. Error indication message is output to the Service Log.
Error	Move Destination Unknown	A801	The Destination Application Entity named in the C-MOVE Request is unknown to Query/Retrieve SCP AE. Error indication message is output to the Service Log.
Error	Identifier does not match SOP class	A900	The C-MOVE identifier contains invalid Elements or values, or is missing mandatory Elements or values for the specified SOP Class or retrieval level. Error indication message is output to the Service Log.
Error	Unable to process	Cxxx	The Move Destination AET is missing in the C-MOVE Request. Error indication message is output to the Service Log.
Pending	Matches are continuing and current match is supplied	FF00	Indicates that the search for further matches is continuing. This is returned when each successful match is returned and when further matches are forthcoming. Pending indication message is output to the Service Log.

Table 1.27. LMT Query/Retrieve Server Service Communication Failure Behavior

Exception	Behavior
Timeout expiry for an expected DICOM Message Request (DIMSE level timeout). I.e. the Query/Retrieve Server SCP AE is waiting for the next C-FIND or C-MOVE Request on an open Association but the timer expires.	The Association is aborted by issuing a DICOM A-ABORT. Error message is output to the Service Log.
Timeout expiry for an expected DICOM PDU or TCP/ IP packet (Low-level timeout). I.e. The Query/ Retrieve Server AE is waiting for the next message PDU but the timer expires.	The Association is aborted by issuing a DICOM A-ABORT. Error message is output to the Service Log.
Association aborted by the SCU or the network layers indicate communication loss (i.e. low-level TCP/IP socket closure)	Error message is output to the Service Log.

1.3.2.3. LMT Modality Worklist Server Application Entity Specification

1.3.2.3.1. SOP Classes

LMT Modality Worklist Server Application Entity provides Standard Conformance to the following SOP Classes:

Table 1.28. SOP Classes for LMT Modality Worklist Server AE

SOP Class Name	SOP Class UID	SCU	SCP
Verification SOP Class	1.2.840.10008.1.1	No	Yes
Modality Worklist Information Model - FIND	1.2.840.10008.5.1.4.31	No	Yes

1.3.2.3.2. Association Establishment Policy

1.3.2.3.2.1. General

LMT Modality Worklist Server AE can both accept and propose Association Requests. The Query/Retrieve Server AE will accept Association Requests for the Verification and Query/Retrieve Services. It will propose Associations for Verification and Storage Services.

1.3.2.3.2.2. Number of Associations

LMT Modality Worklist Server can support multiple simultaneous Associations requested by peer AEs.

1.3.2.3.2.3. Asynchronous Nature

LMT Modality Worklist Server does not support asynchronous communication. Multiple outstanding transactions are not supported. It allows up to one invoked and one performed operation on an Association (it is synchronous). Asynchronous mode of operation is not supported.

Table 1.29. Asynchronous Nature as SCP for LMT Modality Worklist Server AE

Maximum number of outstanding asynchronous transactions	1 (Not Configurable)

1.3.2.3.3. Association Initiation Policy

The Modality Worklist Server AE does not initiate Associations.

1.3.2.3.4. Association Acceptance Policy

1.3.2.3.4.1. Activity - External Peer AE requests MWL query

1.3.2.3.4.2. Description and Sequencing of Activities

The Modality Worklist Server AE accepts Associations only if they have valid Presentation Contexts. If none of the requested Presentation Contexts are accepted then the Association Request itself is rejected. It can be configured to only accept Associations from certain Application Entities.

When Modality Worklist SCUs query the Modality Worklist Server AE the queries run against the MWL items in the local database.

The Modality Worklist Server AE may reject Association attempts as shown in the table below. The Result, Source and Reason columns represent the values returned in the corresponding fields of an ASSO-CIATE-RJ PDU (see PS 3.8, Section 9.3.4).

Table 1.30. Association Rejection Reasons

Result	Source	Reason	Description
2 - rejected transient	provider	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.
1 - rejected permanent	user	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	user	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.

1.3.2.3.4.3. Accepted Presentation Contexts

Table 1.31. Accepted Presentation Contexts for LMT Query/Retrieve Server AE

Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	**UID**	**Name List**	**UID List**		
Verification SOP Class	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Modality Worklist Information Model – FIND	1.2.840.10008.5.1.4.31	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		

If the Called AET is not corresponding to the actual Modality Worklist Server AET, only the Presentation Context for the Verification SOP Class will be accepted.

1.3.2.3.4.4. SOP Specific Conformance

1.3.2.3.4.5. Specific Conformance for Verification SOP Class

LMT Storage Server provides standard conformance to the DICOM Verification Service Class as a SCP. The status code for the C-ECHO is described in the following table:

Table 1.32. C-Echo Response Status Handling Behavior

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

1.3.2.3.4.6. Specific Conformance for Modality Worklist SOP Class

Return attributes depend on the information provided by the connected HIS/RIS. There are no attributes always returned by default. Only those attributes requested in the query identifier are returned. Query responses always return values from the Modality Worklist Server database.

Table 1.33. Modality Worklist C-FIND SCP Supported Elements

Attribute Name	Tag	VR	Types of Matching
Specific Character Set	0008,0005	CS	NONE

Attribute Name	Tag	VR	Types of Matching
Scheduled station AE title	0040,0001	AE	NONE
Scheduled Procedure Step Start Date	0040,0002	DA	S,R
Scheduled Procedure Step Start Time	0040,0003	TM	S,R
Scheduled Performing Physician's Name	0040,0006	PN	S,*
Modality	0008,0060	CS	S
Accession Number	0008,0050	SH	S
Patient's Name	0010,0010	PN	S,*
Patient's ID	0010,0020	LO	S
All others			NONE

Types of Matching:

The types of Matching supported by the C-FIND SCP. An "S" indicates the identifier attribute uses Single Value Matching, an "R" indicates Range Matching, an "*" indicates wildcard matching, a "U" indicates Universal Matching. "NONE" indicates that no matching is supported, but that values for this Element are requested to be returned.

1.3.2.3.4.6.1. Modality Worklist Server AE C-STORE Response

Table 1.34. LMT Modality Worklist Server C-STORE Response Status

Service Status	Further Meaning	Error Code	Behavior
Success	Matching is complete	0000	Success indication message is output to the Service Log
Error	Processing Failure	0110	This is treated as a permanent Failure. The appropriate Status will be sent in the C-FIND Response. Error indication message is output to the Service Log
Canceled	Matching terminated due to cancel request	FE00	This status is returned if a Cancel Request is received from the SCU during the processing of a Modality Worklist request. A cancel indication message is output to the Service Log
Pending	Matching is continuing	FF00	This status is returned with each matching response. A pending indication message is output to the Service Log

1.3.2.3.4.6.2. Modality Server AE Storage Service Communication Failure Reasons

Table 1.35. LMT Modality Server Service Communication Failure Behavior

Exception	Behavior
Association aborted by the SCU or the network layers indicate communication loss (i.e. low-level TCP/IP socket closure)	Error message is output to the Service Log.

1.3.3. Physical Network Interfaces

1.3.3.1. Supported Communication Stacks

DICOM Upper Layer over TCP/IP is supported.

1.3.3.1.1. TCP/IP Stack

LMT inherits their TCP/IP stack from the installed Java Runtime Environment.

1.3.3.2. Physical Network Interface

LMT is indifferent to the physical medium over which TCP/IP executes; it inherits this from the Java Runtime Environment.

1.3.4. Configuration

1.3.4.1. AE Title/Presentation Address Mapping

1.3.4.1.1. Local AE Titles

The local AE Titles and TCP ports are configurable through interface.

Table 1.36. AE Title Configuration Table

Application Entity	Default AE Title	Default TCP/IP Port
LMT Storage Server	LeoPACS	11113
LMT Query/Retrieve Server	LeoQR	6789
LMT Modality Work-list Server	LeoMWL	11112
LMT Disc Publishing	Leonardo	11112

1.3.4.1.2. Remote AE Title

Remote AE Titles, TCP/IP Addresses and ports can be configured through interface.
In the default configuration, Association Requests with any Calling AET will be accepted.

1.3.4.2. Parameters

The following table shows the LMT configuration parameters relevant to DICOM communication. Refer to the LMT Service Manual for details on general configuration capabilities.

Table 1.37. Configuration Parameter Table

Parameter	Configurable (Yes/No)	Default Value
General Parameters		
Listening Port	Yes	11112
Maximum number of simultaneous Associations	Yes	10
Time-out waiting for A-ASSOCIATE RQ on open TCP/IP connection (ARTIM timeout)	Yes	5s
Time-out waiting on an open association for the next message (DIMSE timeout)	Yes	no timeout
Time-out waiting for acceptance or rejection Response to an Association Open Request. (Application Level timeout)	No	no timeout
Time-out waiting on an open association for the next message after sending A-RELEASE RSP or A-ABORT RQ (Closíng timeout)	Yes	500ms
Maximum PDU size the AE can receive	Yes	16352
Maximum PDU size the AE can send	No	65535
Pack Command and Data PDVs in one PDU	Yes	false
Support for the Basic TLS Secure Transport Connection Profile	Yes	Off

Parameter	Configurable (Yes/No)	Default Value
Storage Server AE		
Accepted Called AETs	Yes	LeoPACS
Accepted Calling AETs	Yes	any
Query/Retrieve Server AE		
Accepted Called AETs	Yes	LeoQR
Accepted Calling AETs	Yes	any
Send optional C-MOVE RSPs with Pending Status to the C-MOVE SCU during the retrieve process	Yes	true
Time-out waiting for the A-ASSOCIATE-AC PDU after transmission of the A-ASSOCIATE-RQ to open an association to the Move Destination AE	Yes	5s
Modality Worklist Server AE		
Accepted Called AETs	Yes	LeoMWL
Accepted Calling AETs	Yes	any
Disc Publishing Server AE		
Accepted Called AETs	Yes	Leonardo
Accepted Calling AETs	Yes	any

1.4. Security

1.4.1. Association Level Security

LMT can be configured to accept Association Requests from only a limited list of Calling AE Titles.
In the default configuration, Association requests with any Calling AET and any Called AET will be accepted. However, if the Called AET is not correspondent to any of the actual Storage Server AETs, only acceptance of the Presentation Context for Verification SOP Class will be returned in the Association Acceptance Response (A-ASSOCIATE AC).

1.4.2. Application Level Security

Each LMT module can be configured to require user authentication in order to gain access to the user interface functionalities.

1.5. Annexes

1.5.1. Coerced/Modified Fields

Attribute coercion is configurable for IOD's received by the Storage Server. Attributes can either be mapped or may be filled with "fixed values" depending on the existence or the content(s) of one or more other Attributes.

Patient Information, Patient Demographics and Study Information could either be modified manually using the web based system management tool or updated automatically by information received from RIS.

The coerced/modified Attribute values are provided when a remote Query/Retrieve SCU queries information or when SOP Instances are sent to a remote Storage SCP. Attribute Coercion will be indicated in the appropriate Service Response Status.

1.6. Appendix A. Implementation Statements of IHE Integration Profiles

LMT has implemented the following DICOM service classes:

- DICOM XY Image Storage SCU+SCP
- DICOM Key Object Selection Document SCU+SCP
- DICOM Basic Text SR Storage SCU+SCP
- DICOM Study Root Query/Retrieve Information Model - FIND SCP
- DICOM Study Root Query/Retrieve Information Model - MOVE SCP

According to the following IHE Integration Profiles:

- Scheduled Workflow Integration Profile
- Patient Information Reconciliation Integration Profile
- Consistent Presentation of Images Integration Profile
- Access to Radiology Information Integration Profile
- Key Image Note Integration Profile