ELEKTA

DICOM Conformance Statement
for
Leksell GammaPlan®

Release 8.0

Document: Pd117CONFSTAT edition 2
11 May 2007

Issued by:

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1   Introduction

1.1   Scope and field of application

The scope of this DICOM conformance statement is to facilitate data exchange with equipment of Elekta Neuro Sciences. This document specifies the conformance to the DICOM standard (formally called the NEMA PS3.X-1993 standards). It contains a short description of the applications involved and provides technical information about the data exchange capabilities of the equipment. The main elements describing these capabilities are the supported DICOM service object pairs (SOP) classes, Roles and Transfer Syntaxes.

1.2   Reference documents

Digital Imaging and Communications in Medicine (DICOM). Version 3.0. National Electrical

Manufacturer's Association. Rosslyn, VA, United States of America. 2004.

1.3   Terminology

Term	Explanation
AE	Application Entity
AET	Application Entity Title
AP	Application Profile
Elekta workstation	The workstation that supports Storage Server
FSR	File Set Reader
PDU	Protocol data unit
SCP	Service Class Provider
SCU	Service Class User
SOP	Service Object Pair
UID	Unique Identifier

1.4   Important notes

This Conformance Statement by itself does not guarantee successful interoperability of Elekta equipment with non-Elekta equipment. The user (or user's agent) should be aware of the following issues:

Scope

The goal of DICOM is to facilitate inter-connectivity rather than interoperability. Interoperability refers to the ability of application functions, distributed over two or more systems, to work successfully together. The integration of medical devices into a networked environment may require application functions that are not specified within the scope of DICOM. Consequently, using only the information provided by this Conformance Statement does not guarantee interoperability of Elekta equipment with non-Elekta equipment. It is the user's responsibility to analyze thoroughly the application requirements and to specify a solution that integrates Elekta equipment with non-Elekta equipment.

Validation

Elekta equipment has been carefully tested to assure that the actual implementation of the DICOM interface corresponds with this Conformance Statement. Where Elekta equipment is linked to non-Elekta equipment, the first step is to compare the relevant Conformance Statements. If the Conformance Statements indicate that successful information exchange should be possible, additional validation tests will be necessary to ensure the functionality, performance, accuracy and stability of image and image related data. It is the responsibility of the user (or user's agent) to specify the appropriate test suite and to carry out the additional validation tests.

New versions of the DICOM Standard

The DICOM standard will evolve in future to meet the user's growing requirements and to incorporate new features and technologies. Elekta plans to adapt its equipment to future versions of the DICOM standard. In order to do so, Elekta reserves the right to make changes to its products or to discontinue its delivery. The user should ensure that any non-Elekta provider linking to Elekta equipment also adapts to future versions of the DICOM Standard. If not, the incorporation of DICOM enhancements into Elekta equipment may lead to loss of connectivity (in case of networking) and incompatibility (in case of media).

2   Implementation Model

The Leksell GammaPlan® consists of one Storage Server Application Entity connected to one or more Treatment Planning Workstations.

2.1   Applications data flow diagram
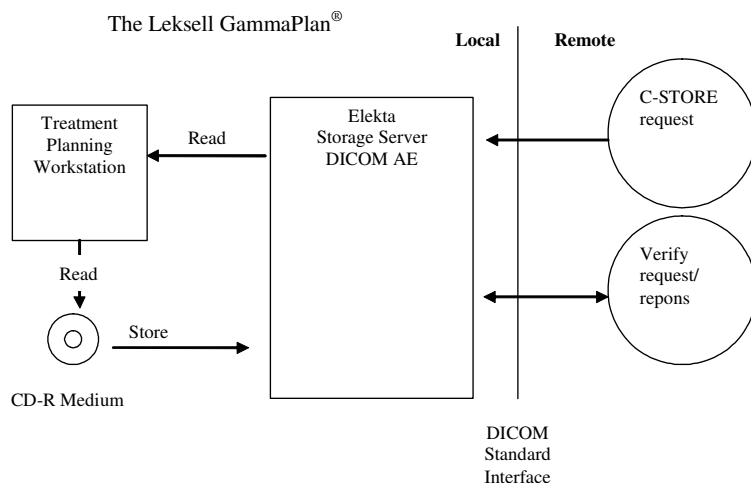
2.2   Functional definitions of Application Entity

Storage Server

The Elekta Storage Server waits for another application to connect at the TCP/IP port number 104. When another application makes a DICOM association request, the Storage Server acts as a SCP for the storage service class: It stores the image as a DICOM object in the database of the Treatment Planning Workstation.

The Storage Server also acts as a SCP for the verification service class: It responds to C-ECHO requests from other applications.

2.3   Sequencing of Real World Activities

Not applicable

3   AE specifications

3.1   Storage Server AE Specification

The Storage Server Application Entity provides Standard Conformance the following DICOM V3.0 SOP classes as a SCP:

SOP Class Name	UID
CT Image Storage – STORE	1.2.840.10008.5.1.4.1.1.2
MR Image Storage – STORE	1.2.840.10008.5.1.4.1.1.4
XA Image Storage – STORE	1.2.840.10008.5.1.4.1.1.12.1
PET Image Storage – STORE	1.2.840.10008.5.1.4.1.1.128
SC Image Storage – STORE	1.2.840.10008.5.1.4.1.1.7
Verification	1.2.840.10008.1.1

Table 1: SOP Classes supported by the Storage Server.

Association Establishment Policies

General

The Elekta Storage Server accepts association in response to C-STORE requests from other Applications Entities. It will only accept C-STORE requests for CT, MR, XA, PET and SC SOP classes and in this case will act as storage service class provider.

It also accepts association in response to C-ECHO requests and act as verification service class provider.

The Storage Server is a LINUX daemon, waits for C-STORE or C-ECHO requests, and performs the necessary operations upon it receiving such requests.

Number of Associations

The number of simultaneous associations that will be accepted by the Elekta Storage Server is limited to 5.

Asynchronous Nature

The Elekta Storage Server does not perform asynchronous operations window negotiation.

Implementation Identifying Information

The Elekta Storage Server does not export any DICOM object. The only occasion where an Implementation Identifier may be used is during the establishment of the association with a DICOM peer. For this reason the implementation identifying information of the OFFIS DCMTK DICOM toolkit has been kept unchanged:

IMPLEMENTATION_CLASS_UID   = 1.22276.0.7230010.3.0.3.5.3

IMPLEMENTATION_VERSION   = OFFIS_DCMTK_353

Association Initiation by Real World Activity

The Elekta Storage Server never initiates an association.

Association Acceptance Policy

Remote System Requests Image Storage

Associated Real World Activity

A DICOM AE sends a storage request to the Elekta Storage Server. If the request is accepted the images are stored on the Elekta Storage Server.

Presentation context table

Presentation Context Table					
Abstract Syntax		Transfer Syntax List		Role	Extended Negotiation
Name	UID	Name	UID		
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		
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		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

Table 2: Presentation context table: C-STORE service

C-STORE SCP conformance

The Elekta Storage Server is Conformance Level 0 Storage SCP. On the Elekta Treatment Planning Workstation, the stored attributes may be accessed only through Elekta applications and only for display. The duration of storage of these attributes is at the user discretion.

Presentation context acceptance criterion

The Elekta Storage Server will accept any context listed in Table 2. There is no check for duplicate contexts.

Transfer syntax selection policies

The preference in acceptance of Transfer Syntaxes is:

Explicit Big Endian above Explicit Little Endian above Implicit Little Endian.

Remote system requests verification

Associated real world activity

A remote DICOM AE wish to verify the application level communication using the C-ECHO command.

Presentation context table

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

Table 3: Presentation context table: C-ECHO service

C-ECHO SCP conformance

The Elekta Storage Server provides standard conformance to the C-ECHO service as a Service Class Provider.

Presentation context acceptance criterion

The only accepted presentation context is defined in Table 3.

Transfer syntax selection policies

The preference in acceptance of Transfer Syntaxes is:

Implicit Little Endian above Explicit Little Endian above Explicit Big Endian

4　Communication profiles

4.1　Supported Communication Stacks

The Elekta Storage Server provides DICOM V3.0 TCP/IP Network Communication Support as defined in part 8 of the DICOM standard.

4.2　TCP/IP Stack

Elekta Storage Server inherits the TCP/IP stack from the LINUX operating system upon which they execute.

4.3　OSI Stack

Not supported.

4.4   Physical Media Support

Specification

The Leksell GammaPlan® can be used to read DICOM part 10 formatted images stored on CD-R with the ISO/IEC 9660 Media Format. All images on the CD-R will be stored on the Elekta Storage Server. I.e. the DICOM Directory File (DICOMDIR) is not used and it is not possible to select separate files to be stored. The Leksell GammaPlan® is then not conformant to any application profiles defined in the DICOM standard.

The following table defines which objects are read by the application and which transfer syntaxes are supported:

Information Object Definition	Service Object Pair Class UID	Transfer Syntax	UID
CT Image	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
MR Image	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
X-Ray Angiographic Image	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
PET Image	1.2.840.10008.5.1.4.1.1.128	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
Secondary Capture Image	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2

Table 4: Media Storage: Objects and Transfer

5   Extensions, Specialization, Privatization

Not applicable.

6   Configuration

Configuration is done by editing application configuration files. It is intended to be performed by Elekta service engineers only.

6.1   AE Title/Presentation Address Mapping

Application Entity Title for the Storage Server is defined in a configuration file. The default value (as generated when the application is installed) is INBOX.

7   Support of Extended Character Sets

Extended characters can be handled, but are not fully supported.

A. Image Objects in the Database

The tables below list the attributes vital for Leksell GammaPlan together with their DICOM tags.

Name	TAG	Usage/Comment
Patient Name	(0010, 0010)	Identification
Patient ID	(0010, 0020)	Identification
Study Date	(0008,0020)	Identification
Study Time	(0008,0030)	Identification
Instance Number	(0020,0013)	User information
Patient Orientation	(0020, 0020)	3D reconstruction
Modality	(0008, 0060)	Identification/Validation See Note 1
Image Orientation Patient	(0020, 0037)	3D reconstruction
Bits Allocated	(0028, 0100)	Pixel data interpretation and display
Bits stored	(0028, 0101)	Pixel data interpretation and display
Samples per pixel	(0028, 0002)	Pixel data interpretation and display
Photometric Interpretation	(0028, 0004)	Pixel data interpretation
High Bit	(0028, 0102)	Pixel data interpretation and display
Pixel Representation	(0028, 0103)	Pixel data interpretation and display
Columns	(0028, 0011)	Pixel data interpretation and display
Rows	(0028, 0010)	Pixel data interpretation and display
Pixel Data	(7FE0, 0010)	Pixel data interpretation and display
Pixel Data Group Length	(7FE0,0000)	Must match length of Pixel Data attribute
Transfer Syntax UID	(0002, 0010)	Criteria to perform byte swapping
Pixel spacing	(0028, 0030)	3D reconstruction
Series Number	(0020, 0011)	Separation of a stack in several series
Image Number	(0020, 0013)	User information
Slice Location	(0020, 1041)	Separation of a stack in several series
Study Instance UID	(0020, 000D)	Separation of a stack in several series
Image Position Patient	(0020, 0032)	3D reconstruction

Slice Thickness	(0018, 0050)	3D reconstruction/validation. See Note 2
Spacing between Slices	(0018, 0088)	3D reconstruction/validation See Note 2
CT rescale slope	(0028, 1053)	Pixel data interpretation and display
CT rescale intercept	(0028, 1052)	Pixel data interpretation and display
Window Center	(0028, 1050)	Pixel data interpretation and display
Window Width	(0028, 1051)	Pixel data interpretation and display
Manufacturer	(0008, 0070)	User information
Series Instance UID	(0020, 000E)	Separation of a stack in several series
SOP Instance UID	(0008, 0018)	Image object identification
Series Type	(0054,1000)	For rejection of dynamic PET studies.
Number Of Frames	(0028,0008)	For rejection of multi frame angio studies.

Table 5: Attributes used by Elekta applications

Note 1
The accepted values for "modality" are: CT, MR, XA, PT, OT and DS. Note DS is a retired enumerated value for modality since the introduction of XA, but it can still be found in some image headers.

Note 2
For a valid 3D reconstruction, it is required that "slice thickness" and "spacing between slices" do not differ more than a application-configured tolerance.