

**Philips Medical Systems
DICOM Conformance Statement**

CT-SR x000

containing the systems
CT SR 4000, CT SR 5000, CT SR 6000, CT SR 7000
and the
T_AV and CT-LX

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Issued by:

Philips Medical Systems Nederland B.V.
Integrated Clinical Solutions, Marketing & Communications
Building QP-0233
P.O. Box 10.000
5680 DA Best
The Netherlands
Tel.: +31 40 2763827
Fax.: +31 40 2763810
email: dicom@best.ms.philips.com

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1 Introduction

This chapter provides general information about the purpose, scope and contents of this DICOM Conformance Statement (DCS).

1.1 Scope and field of application

The scope of this DICOM Conformance Statement is to facilitate data exchange with equipment of Philips Medical Systems. This document specifies the compliance to the DICOM standard (formally called the NEMA PS 3.X-1996 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 Pair (SOP) Classes, Roles, Information Object Definitions (IOD) and Transfer Syntaxes.

The field of application is the integration of the Philips Medical Systems equipment into an environment of medical devices.

This Conformance Statement should be read in conjunction with the DICOM standard and its addenda. The conformance to the DICOM standard is a key element of the Inturis Program (see [INTURIS]).

1.2 Intended audience

This Conformance Statement is intended for:

- (potential) customers,
- system integrators of medical equipment,
- marketing staff interested in system functionality,
- software designers implementing DICOM interfaces.

It is assumed that the reader is familiar with the DICOM standard.

1.3 Contents and structure

The DICOM Conformance Statement is contained in chapter 2 through 7 and follows the contents and structuring requirements of DICOM PS 3.2-1996.

1.4 Used definitions, terms and abbreviations

DICOM definitions, terms and abbreviations are used throughout this Conformance Statement. For a description of these, see NEMA PS 3.3-1996 and PS 3.4-1996.

The word Philips in this document refers to Philips Medical Systems.

1.5 References

- [DICOM] The Digital Imaging and Communications in Medicine (DICOM) standard:
NEMA PS 3.X.
National Electrical Manufacturers Association (NEMA) Publication Sales
1300 N. 17th Street, Suite 1847
Rosslyn, Va. 22209, United States of America

[INTURIS] Philips Inturis Program
Integrated Clinical Solutions
Philips Medical Systems Nederland B.V. (see address at page ii)

1.6 Important note to the reader

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

- **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 Philips equipment with non-Philips equipment. It is the user's responsibility to analyse thoroughly the application requirements and to specify a solution that integrates Philips equipment with non-Philips equipment.

- **Validation**

Philips equipment has been carefully tested to assure that the actual implementation of the DICOM interface corresponds with this Conformance Statement.

Where Philips equipment is linked to non-Philips 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. Philips is actively involved in this evolution and plans to adapt its equipment to future versions of the DICOM Standard. In order to do so, Philips reserves the right to make changes to its products or to discontinue its delivery.

The user should ensure that any non-Philips provider linking to Philips equipment, also adapts to future versions of the DICOM Standard. If not, the incorporation of DICOM enhancements into Philips equipment may lead to loss of connectivity (in case of networking) and incompatibility (in case of media).

Introduction

1.7 General Acronyms and Abbreviations.

The following acronyms and abbreviations are used in the document.

- AE Application Entity
- ACR American College of Radiology
- ANSI American National Standard Institute
- BOT Basic Offset Table
- CD-R Compact Disk Recorder
- CD-M Compact Disk Medical
- CTAV Philips Medical Systems AV Product Line of CT
- CT AVE1 Philips Medical Systems AVE1 CT Scanner
- DCR Dynamic Cardio Review
- DICOM Digital Imaging and Communication in Medicine
- DIMSE DICOM Message Service Element
- DIMSE-C DICOM Message Service Element-Composite
- DIMSE-N DICOM Message Service Element-Normalized
- FSC File Set Creator
- GUI Graphic User Interface
- HIS Hospital Information System
- HL7 Health Level Seven
- IOD Image Object Definition
- ILE Implicit (VR) Little Endian
- NEMA National Electric Manufacturers Association
- PDU Protocol Data Unit
- SC Secondary Capture/Service Class
- SCP Service Class Provider
- SCU Service Class User
- SOP Service Object Pair
- TCP/IP Transmission Control Protocol/Internet protocol
- UID Unique Identifier
- ISIS Information System - Imaging System Interface
- RIS Radiology Information System
- RWA Real World Activity
- SCM Study Component Management
- SOP Service Object Pair
- WLM Worklist Management

2 Implementation model

The CT-SR x000 system and T-AV system (short “CT”) of Philips Medical Systems is a scanner generating Computed Tomography (CT) images. The system can be installed with an Export function based on the DICOM Image Storage to transfer image data from the CT system to a remote system. This DICOM Export function implies the presence of the CT Net I/F option software.

The DICOM Export function is implemented via a DICOM converter box (the MVP™ DMIA box) MVP™ is a trademark by Merge Technologies Inc. The MVP™ “black box” that converts images and related image data in a Philips Medical Systems CT format to DICOM thereby interfacing a non DICOM modality to the DICOM real world. This box is validated and conforms to the DICOM Standard and to this Conformance Statement. See chapter 8 on page 13 for detailed information on the CT Image Storage IOD.

It might be that other types of converter boxes are connected to the CT (not delivered by Philips Medical Systems, possibly installed on hospital project basis). Conformance to the DICOM standard and to this Conformance Statement is not guaranteed for these converter boxes.

2.1 Application Data Flow Diagram

The CT behaves as a single Application Entity. The related Implementation Model is shown in Figure 2-1 on page 5.

The Export function is activated by an operator request. The images to be transferred are selected from the user interface, followed by the selection of the destination.

The CT is able to transfer the following types of images:

- Normal scans: fast scan, serial scan
- Dynamic scans
- Volume scans
- Scanograms

The system does **not** support the transfer of Tomoscan 350 (converted) images, Graphical Annotated images and any images which are result of analysis.

Image data to be transferred are instances of the DICOM CT SOP Class. The images transferred are intended for viewing purposes. Postprocessing like MPR, 3D reconstruction and rendering may be possible, depending on the capabilities of the workstation receiving the CT images.

The system supports verification requests of the operator (mostly the service engineer) and answers verification requests from remote systems.

2.2 Functional definition of Application Entities

The CT DICOM Export application entity acts as a Service Class User (SCU) of the Storage Service Class. After invoking it will open an association to the remote system. For each image to be transported a retrieve action from the internal CT storage will take place followed by the

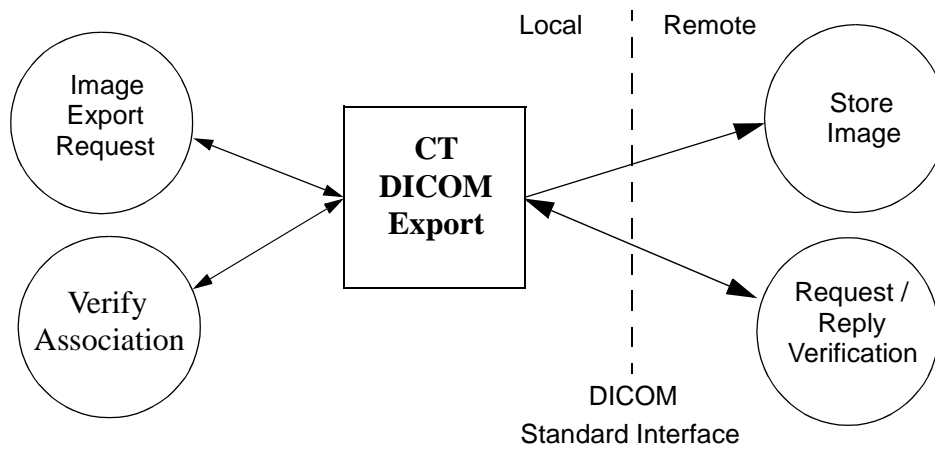


Figure 2-1: The CT Implementation Model

conversion to a DICOM message to be sent to the remote system.

The CT DICOM Export application entity supports also the Verification SOP Class both as SCU and SCP.

2.3 Sequencing of Real World Activities

Not applicable.

3 AE Specifications

CT system acts as a single Application Entity.

3.1 AE CT DICOM Export Specification

The CT DICOM Export Application Entity provides Standard Conformance to the following DICOM 3.0 SOP classes as an SCU:

Table 3-1: Supported SOP classes by the CT-SR DICOM Export AE as SCU

<i>SOP class Name</i>	<i>UID</i>
Verification	1.2.840.10008.1.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2

The CT DICOM Export Application Entity provides Standard Conformance to the following DICOM 3.0 SOP classes as an SCP:

Table 3-2: Supported SOP classes by the CT-SR DICOM Export AE as SCP

<i>SOP class Name</i>	<i>UID</i>
Verification	1.2.840.10008.1.1

3.1.1 Association Establishment Policies

3.1.1.1 General

The maximum PDU size is 4K (default) on associations. The PDU size is configurable up to 16K.

3.1.1.2 Number of Associations

The CT will attempt to establish one association at a time. (Multiple associations are not supported)

3.1.1.3 Asynchronous Nature

CT DICOM Export does not support asynchronous operations and will not perform asynchronous window negotiation.

3.1.1.4 Implementation Identifying Information

Table 3-3: Supported SOP classes by the CT-SR DICOM Export AE as SCU

<i>System</i>	<i>Implementation Class UID</i>	<i>Version Name</i>
CT-SR 4000	1.3.46.670589.10.8.8000143.1	HCM/M_SR4000_1
CT-SR 5000	1.3.46.670589.10.9.8000143.1	HCM/M_SR5000_1
CT-SR 6000	1.3.46.670589.10.10.8000143.1	HCM/M_SR6000_1
CT-SR 7000	1.3.46.670589.10.11.8000143.1	HCM/M_SR7000_1
T-AV	1.3.46.670589.10.15.8000143.1	HCM/M_T_AV_1
CT-LX	1.3.46.670589.10.6.800143.1	HCM/M_LX_1

3.1.2 Association Initiation Policy

CT DICOM Export initiates associations as a result of the following events:

- The CT operator requests export of one or more images to a remote system (section 3.1.2.1), specified within the MVP box user interface.
- The CT operator requests for Association (i.e. application level communication) verification (section 3.1.2.2).

3.1.2.1 Image export from CT system

3.1.2.1.1 Associated Real-World Activity

The CT DICOM Export function will be accessible through the CT user interface (Select Mode 43). The user will select the patient (also called examination), one or more images of that selected patient and the destination. The selected images are marked.

After the (successful, partly successful or failed) transfer of the selected images, the association is released.

3.1.2.1.2 Proposed Presentation Contexts

CT DICOM Export will propose the following presentation contexts:

Table 3-4: Proposed Presentation Contexts for the image export

<i>Presentation Context table</i>					
<i>Abstract Syntax</i>		<i>Transfer Syntax</i>		<i>Role</i>	<i>Extended Negotiation</i>
<i>Name</i>	<i>UID</i>	<i>Name List</i>	<i>UID List</i>		
CT Image Storage	1.2.840.10008.5 .1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

3.1.2.1.3 SOP Specific Conformance to Storage SOP Class

During and after the transfer of images, the user interface shows an image counter indicating the number of successfully transferred images and the total number of images to transfer.

When the transfer is ended, CT behaves as follows on the possible response states of the C-STORE messages:

Table 3-5: Behaviour on successful, unsuccessful and warning C-STORE response states

<i>C-STORE return status</i>	<i>Behaviour of the CT-SR system</i>
Success (status 0000) on all C-STORE messages	Status 'Completed' is shown on the console at the end of the transfer.
Refused (status A7xx) on one or more C-STORE messages	Status 'Incomplete' is shown on the console at the end of the transfer.
Error (status A9xx or Cxxx or 01xx) on one or more C-STORE messages	Status 'NetError' is shown on the console at the end of the transfer.
Warning (status B00x) on one or more C-STORE messages	All images are transferred successfully. Status 'Completed' is shown on the console, the warning is not shown or logged.

The CT system will **not** retry after a failed transfer of one or more images.

The association is released when ready with the (complete or incomplete) transfer of selected images.

Extended negotiation is not supported.

Table 3-6 lists the applied Conditional and Optional attributes in the CT images. The full list of applied attributes is given in chapter 8 on page 13.

Table 3-6: Applied Conditional and Optional attributes of the CT IOD

<i>IE</i>	<i>Module</i>	<i>Conditional attributes</i>	<i>Optional attributes</i>
Patient	Patient	-	-
Study	General Study	-	-
	Patient Study	-	Admitting Diagnoses Description
Series	General Series	Patient Position	Protocol Name
Frame of Reference	Frame of Reference	-	-
Equipment	General Equipment	-	Institution Name, Station Name, Institutional Department Name, Manufacturer's Model name, Device Serial Number, Software Version(s)

Table 3-6: Applied Conditional and Optional attributes of the CT IOD (Continued)

<i>IE</i>	<i>Module</i>	<i>Conditional attributes</i>	<i>Optional attributes</i>
Image	General Image	Image Date, Image Time, Patient Orientation	Referenced Image Sequence, Image Comments
	Image Plane	-	Slice Location
	Image Pixel	-	-
	Contrast/Bolus	-	-
	CT Image	-	Reconstruction Diameter, Gantry/Detector Tilt, Table Height, Rotation Direction, Exposure Time, X-Ray Tube Current, Exposure, Convolution Kernel
	VOI LUT	Window Width	Window Center
	SOP Common	SOP Class UID, SOP Instance UID	Instance Creation Date, Instance Creation Time, Instance Creator UID

3.1.2.2 Verify Application Level Communication

3.1.2.2.1 Associated Real-World Activity

The CT DICOM Export AE supports the Verification requests from the operator (usually the service engineer). This results in trying to setup an association to the selected remote system. The association is released after the verification.

3.1.2.2.2 Proposed Presentation Contexts

CT DICOM Export will propose the following presentation, see Table 3-4 on page 7.

3.1.2.2.3 SOP Specific Conformance to the Verification SOP Class

CT-SR provides standard conformance.

3.1.3 Association Acceptance Policy

The CT-SR DICOM Export Application Entity accepts associations for only one purpose: to allow remote applications to verify application level communication.

3.1.3.1 Verify Application Level Communication

3.1.3.1.1 Associated Real-World Activity

CT accepts associations from systems that wish to verify application level communication using the C-ECHO command.

3.1.3.1.2 Presentation Context Table

See table Table 3-4 on page 7.

3.1.3.1.3 C-ECHO SCP Conformance

CT-SR provides standard conformance.

3.1.3.1.4 Presentation Context Acceptance Criterion

Not applicable.

3.1.3.1.5 Transfer Syntax Selection Policies

Not applicable.

4 Communication Profiles

4.1 TCP/IP Stack

CT provides DICOM 3.0 TCP/IP Network Communication Support as defined in Part 8 of the DICOM 3.0 Standard.

4.1.1 Physical Media Support

CT supports ISO 8802-3 10BASE5 (Thick-wire), 10BASE2 (Thin-wire) and 10BASET (Twisted-pair) Ethernet.

5 Extensions/Specializations/Privatizations

Not applicable.

6 Configuration

The configuration of a CT system is done by updating the DMIA-DICOM configuration files. It is intended to be done by Philips service engineers only.

6.1 AE Title/Presentation Address mapping

6.1.1 Local AE Titles and Presentation Addresses

The local Application Entity Title and Presentation Address are configurable.

6.1.2 Remote AE Titles and Presentation Addresses

All remote applications to be selected as export destination (SCP) are configurable for the following items:

- The Application Entity Title of the remote application.
- The Presentation Address (i.e. IP-address plus port number) at which the remote application should accept association requests.
- The Remote Host Name of the system on which the remote application resides.

6.2 Configurable parameters

See for configurable parameters/option/choices also the accompanying system documentation.

The following parameters are configurable for this AE (Local):

- Local AE Title
- Local IP Address
- Max PDU, up to 16K.
- Calling AE Title
- The Referenced Image Sequence availability.

The following parameters are configurable for each remote AE:

- Called AE Title
- remote AE Title
- responding TCP/IP Port Number

- Remote IP Address / Host name

The following local timeout parameters are configured for the AE:

Table 6-1: description of some local timeout parameters

<i>Parameter Description</i>	<i>Default Value</i>
The number of seconds to use as a timeout waiting for an association request or waiting for the peer to shut down an association.	30
The number of seconds to wait for a reply to an associate request.	15
The number of seconds to wait for a reply to an associate release.	15
The number of seconds to wait for a network write operation to be accepted.	15
Number of seconds to wait for a network connect to be accepted.	15
The number of seconds to use as a timeout waiting for an association request or waiting for the peer to shut down an association.	30

There are many other parameters which can be configured. These parameters are beyond the scope of this document and should only be altered by Philips service engineers.

7 Support of Extended Character Sets

Not applicable.

Applied Computed Tomography (CT) Image IOD

8 Applied Computed Tomography (CT) Image IOD

This section specifies the Computed Tomography (CT) Image Information Object Definition (IOD) implemented by the CT.

The modules selected from the IOD module table of DICOM are given in the table below.

Table 8-1: CT IOD Modules

<i>IE</i>	<i>Module</i>	<i>Usage</i>	<i>Reference</i>
Patient	Patient	M	Table 8-2
Study	General Study	M	Table 8-3
Series	General Series	M	Table 8-4
Frame of Reference	Frame of Reference	M	Table 8-5
Equipment	General Equipment	M	Table 8-6
Image	General Image	M	Table 8-7
	Image Plane	M	Table 8-8
	Image Pixel	M	Table 8-9
	Contrast/Bolus	C	Table 8-10
	CT Image	M	Table 8-11
	VOI LUT	U	Table 8-12
	SOP Common	M	Table 8-13

The details of these applied modules are given in the tables below. The list of possible values are given (if applicable). The situation that an attribute is present conditionally/optionally or that an attribute may contain a zero length value, is indicated too. Standard DICOM Conditions and Defined/Enumerated Values are applicable but are not shown in the tables.

Table 8-2: CT Image Storage SOP Class - Patient Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Patient's Name	0010,0010	
Patient ID	0010,0020	Zero length value if not entered by the user. Can optionally be stripped of leading 0's. For the SR the maximum number of characters is 10 and for the LX the maximum number of characters is 9. Default is with leading 0's.
Patient's Birth Date	0010,0030	Zero length value if not entered by the user.
Patient's Sex	0010,0040	Applied value(s): F, M, O

Table 8-3: CT Image Storage SOP Class - General Study Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Study Date	0008,0020	
Study Time	0008,0030	
Accession Number	0008,0050	Always zero length value.
Referring Physician's Name	0008,0090	Always zero length value.
Study Instance UID	0020,000D	
Study ID	0020,0010	

Table 8-4: CT Image Storage SOP Class - General Series Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Modality	0008,0060	Applied value(s): CT
Protocol Name	0018,1030	
Patient Position	0018,5100	
Series Instance UID	0020,000E	
Series Number	0020,0011	
Laterality	0020,0060	Always Empty

Table 8-5: CT Image Storage SOP Class - Frame of Reference Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Frame of Reference UID	0020,0052	
Position Reference Indicator	0020,1040	Default Value: UNKNOWN

Table 8-6: CT Image Storage SOP Class - General Equipment Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Manufacturer	0008,0070	Applied value(s): Philips Medical Systems

Table 8-6: CT Image Storage SOP Class - General Equipment Module (Continued)

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Institution Name	0008,0080	
Station Name	0008,1010	
Institutional Department Name	0008,1040	
Manufacturer's Model Name	0008,1090	Applied value(s): LX
Device Serial Number	0018,1000	
Software Version(s)	0018,1020	Contains the MVP software version.

Table 8-7: CT Image Storage SOP Class - General Image Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Image Date	0008,0023	
Image Time	0008,0033	
Referenced Image Sequence	0008,1140	
> Referenced SOP Class UID	0008,1150	
> Referenced SOP Instance UID	0008,1155	
Image Number	0020,0013	
Patient Orientation	0020,0020	
Image Comments	0020,4000	Only present if entered by the user.

Table 8-8: CT Image Storage SOP Class - Image Plane Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Slice Thickness	0018,0050	
Image Position (Patient)	0020,0032	
Image Orientation (Patient)	0020,0037	
Slice Location	0020,1041	Configurable: as mentioned on scanner/film default is the DICOM Z-axis.
Pixel Spacing	0028,0030	

Table 8-9: CT Image Storage SOP Class - Image Pixel Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Photometric Interpretation	0028,0004	Applied value(s): MONOCHROME2
Rows	0028,0010	
Columns	0028,0011	
Bits Allocated	0028,0100	Applied value(s): 16
Bits Stored	0028,0101	Applied value(s): 12
High Bit	0028,0102	Applied value(s): 11
Pixel Representation	0028,0103	Applied value(s): 0000
Pixel Data	7FE0,0010	

Table 8-10: CT Image Storage SOP Class - Contrast/Bolus Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Contrast/Bolus Agent	0018,0010	

Table 8-11: CT Image Storage SOP Class - CT Image Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Image Type	0008,0008	Applied value(s): ORIGINAL \ PRIMARY \ AXIAL, LOCALIZER \ DYNAMIC, NORMAL, VOLUME
KVP	0018,0060	
Reconstruction Diameter	0018,1100	
Gantry/Detector Tilt	0018,1120	
Table Height	0018,1130	
Rotation Direction	0018,1140	
Exposure Time	0018,1150	
X-ray Tube Current	0018,1151	
Exposure	0018,1152	
Convolution Kernel	0018,1210	

Applied Computed Tomography (CT) Image IOD

Table 8-11: CT Image Storage SOP Class - CT Image Module (Continued)

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Acquisition Number	0020,0012	
Samples per Pixel	0028,0002	Applied value(s): 1
Photometric Interpretation	0028,0004	Applied value(s): MONOCHROME2
Bits Allocated	0028,0100	Applied value(s): 16
Bits Stored	0028,0101	Applied value(s): 12
High Bit	0028,0102	Applied value(s): 11
Rescale Intercept	0028,1052	Applied value(s): -1200
Rescale Slope	0028,1053	Applied value(s): 1

Table 8-12: CT Image Storage SOP Class - VOI LUT Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Window Center	0028,1050	Two values are possible (for multiple viewing purpose).
Window Width	0028,1051	Two values are possible (for multiple viewing purpose).

Table 8-13: CT Image Storage SOP Class - SOP Common Module

<i>Attribute Name</i>	<i>Tag</i>	<i>Note</i>
Instance Creation Date	0008,0012	
Instance Creation Time	0008,0013	
Instance Creator UID	0008,0014	
SOP Class UID	0008,0016	Applied value(s): 1.2.840.10008.5.1.4.1.1.2
SOP Instance UID	0008,0018	Is determined at export. If an image is exported for the second time, another UID will be generated.

9 Remarks, Implementation restrictions and choices.

- It is not allowed to use the “=” character in the Patient Name, for this “=” character will be exported. Exporting a “=” character in is not allowed according the DICOM standard.
- The Scanogram and Slices are contained in one Series, or every image in a different Series (configurable in MVP box)
- The Frame of reference is always identical for slices and the scanogram, notwithstanding if the option Reference Image Sequence is present or not.

The following restrictions/remarks apply to the (DICOM) MVP box for CT/LX;

- To provide for comment information (in the DICOM header) the service engineer must modify the *merge.ini* file at installation;
 - 1030_procedure = 4
 - 1050_physician = 5
- Entering the Service mode (by pressing the F3 button) may take about 10 seconds.
- When transfer problems are encountered the speed of the MVP box need to be adapted by setting the *CPU cache off* (in the BIOS section of the MVP box)
- The image transfer speed is (then) considerably slower than the CT/SR box; i.e.
 - 320 x 320 Image transfer: 6 sec.
 - 512 x 512 Image transfer: 17 sec.