BrainLAB

Technical Publication

DICOM CONFORMANCE STATEMENT

PatXfer RT 1.0

Document Revision 3

October 4, 2007

1 Conformance Statement Overview

This is a conformance statement for the BrainLAB software PatXfer RT. The main purpose of this software is to import and convert DICOM data to the BrainLAB advanced file format (xBrain) and vice versa.

The DICOM import part of the application is

- Browse and display of DICOM files (simple message files as well as standard DICOM files).
- Query remote DICOM archives.
- Retrieve DICOM data from archives.

The DICOM export part of the application is

- Send DICOM data to another DICOM application or archive.
- Write DICOM data to the file system (no media interchange application profile supported so far).

Note: There is no direct way e.g. to read DICOM files and send them to a remote system. All you can do is to import DICOM data and convert it to the BrainLAB advanced file format (xBrain) – and therefore loses some of its information – or you can convert xBrain data to DICOM and export it.

SOP Classes	User Of Service (SCU)	Provider Of Service (SCP)
Transfer		
CR Image Storage	No	Yes
CT Image Storage	No	Yes
MR Image Storage	Yes	Yes
Positron Emission Tomography Image Storage	No	Yes
RT Plan Storage	Yes	Yes
RT Structure Set Storage	Yes	Yes
Secondary Capture (SC) Image Storage	No	Yes
Standalone PET Curve Storage	No	Yes
X-Ray Angiographic Image Storage	No	Yes
X-Ray Radiofluoroscopic (RF) Image Storage	No	Yes
Query/Retrieve		
Patient Root Query/Retrieve Information Model - FIND	Yes	No
Patient Root Query/Retrieve Information Model - MOVE	Yes	No
Study Root Query/Retrieve Information Model - FIND	Yes	No
Study Root Query/Retrieve Information Model - MOVE	Yes	No
Patient/Study Only Query/Retrieve Information Model - FIND	Yes	No
Patient/Study Only Query/Retrieve Information Model - MOVE	Yes	No

Table 1-1: Network services supported by PatXfer RT

Media Storage Application Profile	Write Files (FSC or FSU)	Read Files (FSR)
Compact Disc – Recordable		
General Purpose CD–R	No	Yes

Table 1-2: Media Services supported by PatXfer RT

2 Table Of Contents

3 Introduction

3.1 Revision History

Document Version	Date of Issue	Author	Description
1	March 9, 2004		Draft
2	February 15, 2005		Released Revision
3	October 4, 2007		Update of references

3.2 Audience

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

3.3 Remarks

DICOM, by itself, does not guarantee interoperability. However, the Conformance Statement facilitates a first-level validation for interoperability between different applications supporting the same DICOM functionality. The Conformance Statement should be read and understood in conjunction with the DICOM Standard [1]. However, by itself it is not guaranteed to ensure the desired interoperability and a successful interconnectivity.

The user should be aware of the following important issues:

- The comparison of different conformance statements is the first step towards assessing interconnectivity between BrainLAB and non–BrainLAB equipment.

- This Conformance Statement is not intended to replace validation with other DICOM equipment to ensure proper exchange of information intended. An acceptance protocol is available to validate the desired level of connectivity.

- The DICOM standard will evolve to meet the users' future requirements. BrainLAB reserves the right to make changes to its products or to discontinue its delivery.

3.4 Abbreviations

There are a variety of terms and abbreviations used in the document that are defined in the DICOM Standard. Abbreviations and terms are as follows:

AE	DICOM Application Entity
AET	Application Entity Title
CD-R	Compact Disk Recordable
FSC	File-Set Creator
FSU	File-Set Updater
FSR	File-Set Reader
IOD	(DICOM) Information Object Definition
ISO	International Standard Organization

PDU	DICOM Protocol Data Unit
Q/R	Query and Retrieve
SCU	DICOM Service Class User (DICOM client)
SCP	DICOM Service Class Provider (DICOM server)
SOP	DICOM Service-Object Pair
xBrain	BrainLAB advanced file format

3.5 References

[1] Digital Imaging and Communications in Medicine (DICOM) 3.0, NEMA PS 3.1-3.18 – 2004

BrainLAB uses DICOM by Merge.

4 Networking

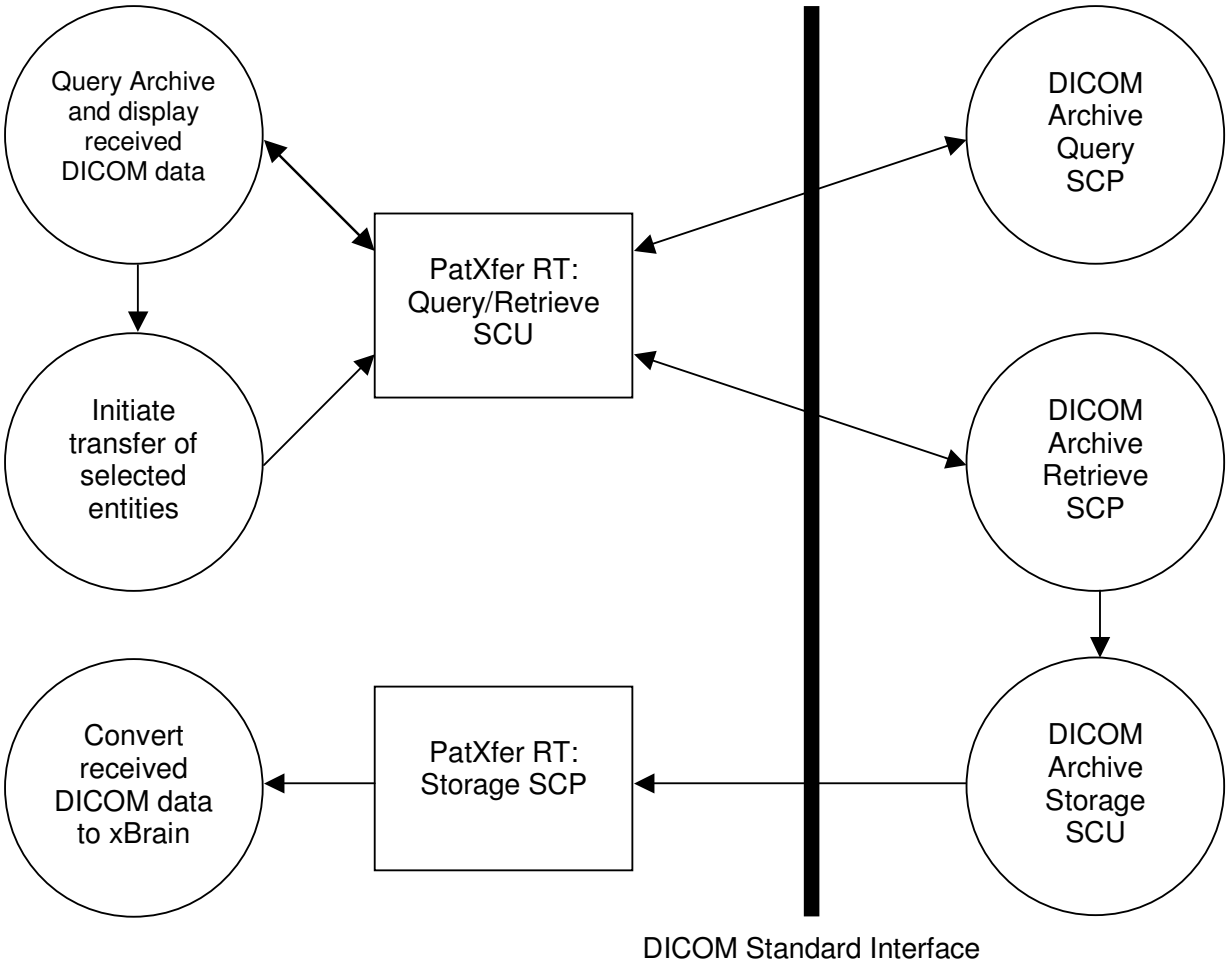
4.1 Implementation Model

The BrainLAB PatXfer RT application is an implementation of:

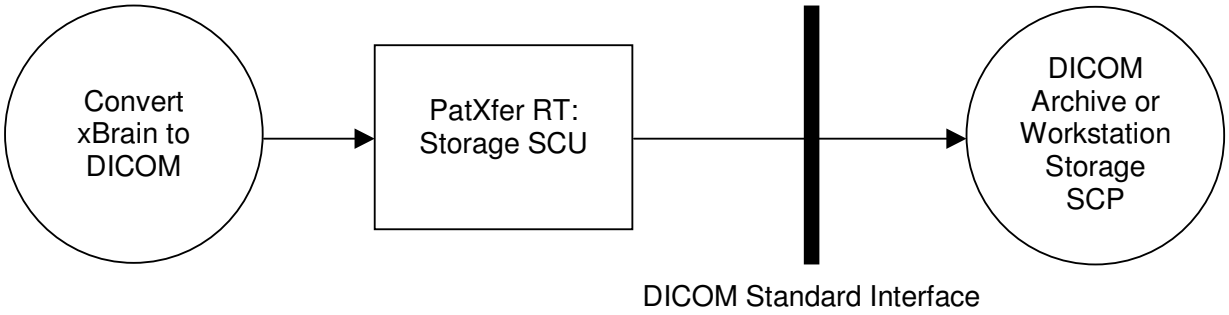
- A Query/Retrieve SCU to query DICOM archives and to initiate a move request for the queried archive.
- A Media File Set Reader to load DICOM data from the file system.
- A Storage SCU that sends DICOM data to a DICOM archive or workstation.
- An application to convert DICOM RT data (RTPLAN, RTSTRUCT) and DICOM image data (CT, MR, PET, XA, CR, SC) into the BrainLAB advanced file format (xBrain).
- An application to convert data from the BrainLAB advanced file format (xBrain) into DICOM image data (CT, MR) and into DICOM RT data (RTPLAN, RTSTRUCT).

4.1.1 Application Data Flow Diagram

The Query/Retrieve SCU and Storage SCP:



The Storage SCU:



4.1.2 Functional Definition of Application Entity (AE)

Some communications and data transfer with remote AE's are accomplished utilizing the DICOM protocol over a network using the TCP/IP protocol stack.

- Query and Retrieve:
  The user wants to find a certain dataset in a DICOM archive. PatXfer RT initiates an association as a Q/R SCU negotiating all models. The find request can be performed (depending on the negotiated models) on all DICOM levels (patient, study, series or instance). For a selected DICOM entity (patient, study, series or instance) a move request can be performed. The application supplies all unique keys for the requested level. The move response, indicating the storage-progress, is graphically evaluated.

- Storage SCP:
  During a move operation a DICOM Storage SCP is invoked. PatXfer RT accepts an association with a Storage SCU negotiating any of the SOP Classes listed in Table 4-3. The received data is – with user interaction – converted to the BrainLAB advanced file format (xBrain).

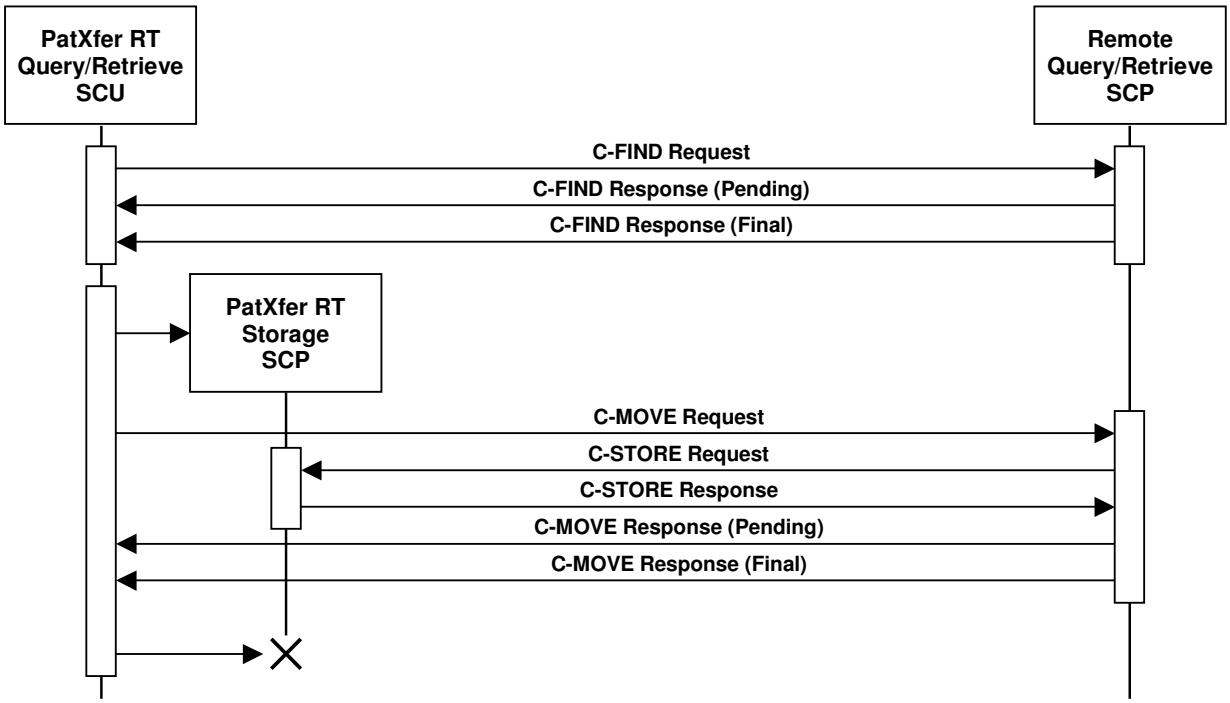
- Storage SCU:
  PatXfer RT loads data from the BrainLAB advanced file format (xBrain), converts it to DICOM – with user interaction – and initiates an association with a Storage SCP negotiating all SOP's listed in Table 4-3. The converted DICOM data is then sent to the remote DICOM Storage SCP.

4.1.3 Sequencing Of Real World Activities

PatXfer RT Query/Retrieve SCU performs a sequencing of real world activities as follows:

1. Query Archive and display received DICOM data:
   a. Send DICOM Query/Retrieve C-FIND request.
   b. Receive DICOM Query/Retrieve C-FIND responses.
2. User selects data to retrieve.
3. Initiate transfer of selected entities:
   a. Start the DICOM Storage SCP
   b. Send a DICOM Query/Retrieve C-MOVE request
   c. Receive DICOM C-STORE requests with the requested SOP instances.
   d. Receive DICOM Query/Retrieve C-MOVE responses
   e. Stop the DICOM Storage SCP
4. Convert received DICOM data to xBrain.

Sequence Constraints:



4.2 Application Entity Specifications

4.2.1 PatXfer RT Specification

4.2.1.1 SOP Classes and Transfer Syntaxes

PatXfer RT sends or receives a C-ECHO request in order to test the connection to a remote AE. It provides standard conformance to the following DICOM V3.0 SOP Classes:

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

Table 4-1: Supported Verification SOP Classes

PatXfer RT is able to query a remote archive. It provides Standard Conformance to the following DICOM V3.0 SOP Classes:

SOP Class Name	SOP Class UID	SCU	SCP
Patient Root Query/Retrieve Information Model - FIND	1.2.840.10008.5.1.4.1.2.1.1	Yes	No
Patient Root Query/Retrieve Information Model - MOVE	1.2.840.10008.5.1.4.1.2.1.2	Yes	No
Study Root Query/Retrieve Information Model - FIND	1.2.840.10008.5.1.4.1.2.2.1	Yes	No
Study Root Query/Retrieve Information Model - MOVE	1.2.840.10008.5.1.4.1.2.2.2	Yes	No
Patient/Study Only Query/Retrieve Information Model - FIND	1.2.840.10008.5.1.4.1.2.3.1	Yes	No
Patient/Study Only Query/Retrieve Information Model - MOVE	1.2.840.10008.5.1.4.1.2.3.2	Yes	No

Table 4-2: Supported Query/Retrieve SOP Classes

PatXfer RT imports and exports DICOM data. It provides Standard Conformance to the following DICOM V3.0 SOP Classes:

SOP Class Name	SOP Class UID	SCU	SCP
CR Image Storage	1.2.840.10008.5.1.4.1.1.1	No	Yes
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Yes	Yes
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Yes	Yes
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	No	Yes
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	Yes	Yes
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	Yes	Yes
Secondary Capture (SC) Image Storage	1.2.840.10008.5.1.4.1.1.7	No	Yes
Standalone PET Curve Storage	1.2.840.10008.5.1.4.1.1.129	No	Yes
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	No	Yes
X-Ray Radiofluoroscopic (RF) Image Storage	1.2.840.10008.5.1.4.1.1.12.2	No	Yes

Table 4-3: Supported Storage SOP Classes

PatXfer RT supports the following transfer syntaxes. In an association negotiation the syntaxes are proposed in the order of appearance in the list.

Transfer Syntax Name	Transfer Syntax UID
DICOM Implicit VR Little Endian	1.2.840.10008.1.2
DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1
DICOM Explicit VR Big Endian	1.2.840.10008.1.2.2

Table 4-4: Supported Transfer Syntaxes

4.2.1.2 Association Policies

4.2.1.2.1 General

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

Application Context Name	1.2.840.10008.3.1.1.1

4.2.1.2.2 Number of Associations

For both association initiation and acceptance:

Maximum number of simultaneous Associations	1

4.2.1.2.3 Asynchronous Nature

The PatXfer RT does not support asynchronous communication (multiple outstanding transactions over a single association).

Maximum number of outstanding asynchronous transactions	1

4.2.1.2.4 Implementation Identifying Information

The implementation information for this Application Entity is:

Implementation Class UID	1.2.276.0.20.1.1.4.1.0.0.4
Implementation Version Name	PatXferRT10_DEN4

4.2.1.3 Association Initiation Policy

PatXfer RT initiates an association in these cases:

1. Find: The user tries to find a specific entity in a remote DICOM archive.

2. Retrieve: The user wants to retrieve a specific entity from the remote DICOM archive and wants to convert it to the BrainLAB advanced file format (xBrain).

3. Store: The user loaded a dataset in the BrainLAB advanced file format (xBrain) and wants to convert it to the DICOM format and send it to a remote DICOM node.

4.2.1.3.1 Activity – Find

4.2.1.3.1.1 Description and Sequencing of Activities

A DICOM Query/Retrieve C-FIND request is performed when the user queries the remote DICOM archive for patients, studies, series or instances.

4.2.1.3.1.2 Proposed Presentation Contexts

Presentation Context Table			
Abstract Syntax	**Transfer Syntax**	**Role**	**Ext. Neg.**
All SCU SOP Classes defined in Table 4-1 and all FIND SCU SOP Classes as defined in Table 4-2	All Transfer Syntaxes as defined in Table 4-4	SCU	None
		SCU	None
		SCU	None

Table 4-5: Proposed Presentation Contexts for Activity Find.

4.2.1.3.1.3 SOP Specific Conformance

PatXfer RT provides standard conformance to the DICOM Verification Service Class and to the DICOM Query/Retrieve FIND SOP Classes. No extended negotiation is implemented.

For the patient-root and patient/study only model, the user may restrict the patient query by the following attributes:

Attribute Name	Tag
Patient's Name	(0010,0010)
Patient ID	(0010,0020)

For the study-root model, the user may restrict the patient/study query by the following attributes:

Description	Tag (hex)
Patient's Name	0010,0010
Patient ID	0010,0020
Study Date	0008,0020

4.2.1.3.2 Activity – Retrieve

4.2.1.3.2.1 Description and Sequencing of Activities

On user selection of a specific DICOM study or series (depends on the available SOP Class for Query/Retrieve), a move request is performed. The storage target for receiving the DICOM data (the AET with which the move-request is equipped) is the PatXfer RT application itself.

The Move operation only can be invoked after a Find operation. See chapter 4.1.3 for a detailed sequencing diagram.

4.2.1.3.2.2 Proposed Presentation Contexts

Presentation Context Table			
Abstract Syntax	**Transfer Syntax**	**Role**	**Ext. Neg.**
All SCU SOP Classes defined in Table 4-1 and all SCU MOVE SOP Classes as defined in Table 4-2	All Transfer Syntaxes as defined in Table 4-4	SCU	None
		SCU	None
		SCU	None

Table 4-6: Proposed Presentation Contexts for Activity Move.

4.2.1.3.2.3 SOP Specific Conformance

PatXfer RT provides standard conformance to the DICOM Verification Service Class and to the DICOM Query/Retrieve MOVE SOP Classes. No extended negotiation is implemented.

4.2.1.3.3 Activity – Store

4.2.1.3.3.1 Associated Real-World Activity

After successful conversion of the selected BrainLAB xBrain data to DICOM a storage request is performed to send the DICOM data to a remote Storage SCP. The remote Storage SCP must be one of the AETs known by PatXfer RT.

4.2.1.3.3.2 Proposed Presentation Contexts

Presentation Context Table			
Abstract Syntax	**Transfer Syntax**	**Role**	**Ext. Neg**
All SCU SOP Classes as defined in Table 4-1 and Table 4-3	All Transfer Syntaxes as defined in Table 4-4	SCU	None
		SCU	None
		SCU	None

Table 4-7: Proposed Presentation Contexts for Activity Store.

4.2.1.3.3.3 SOP Specific Conformance

PatXfer RT provides standard conformance to the DICOM Verification Service Class and to the DICOM Storage SOP Classes. No extended negotiation is implemented.

See chapter 8.1.2 for further information on acceptance of SOP Instances, i.e. whether PatXfer RT is able to import and convert the DICOM data.

4.2.1.4 Association Acceptance Policy

PatXfer RT accepts an association in this case:

1. Retrieve: The user wants to retrieve a specific entity from the remote DICOM archive and wants to convert it to the BrainLAB advanced file format (xBrain).

4.2.1.4.1 Activity – Retrieve

4.2.1.4.1.1 Associated Real-World Activity

On user selection of a specific DICOM entity a move request is performed. To receive the requested SOP instances a Storage SCP is invoked. The Storage SCP is only active during a DICOM Query/Retrieve C-MOVE request and automatically stopped after receive of the final C–MOVE response

4.2.1.4.1.2 Proposed Presentation Contexts

Presentation Context Table			
Abstract Syntax	**Transfer Syntax**	**Role**	**Ext. Neg**
All SOP Classes as defined in Table 4-1 and Table 4-3	All Transfer Syntaxes as defined in Table 4-4	SCU	None
		SCU	None
		SCU	None

Table 4-8: Storage SCP Presentation Contexts.

4.2.1.4.1.3 SOP Specific Conformance

PatXfer RT provides standard conformance to the DICOM Verification Service Class and to the DICOM Storage SOP Classes. No extended negotiation is implemented.

The received DICOM SOP Instances will be converted to the BrainLAB advanced file format (xBrain). Therefore some of the SOP specific information is lost. See chapter 8.1 for further information on exported IODs.

4.2.1.4.1.4 Presentation Context Acceptance Criterion

PatXfer RT accepts multiple presentation contexts containing the same abstract syntax.

4.2.1.4.1.5 Transfer Syntax Selection Policy

The first Transfer Syntax encountered in the configuration file, which matches a Transfer Syntax offered for a given Presentation Context, will be selected as the accepted Transfer Syntax for that Presentation Context.

4.3 Network Interfaces

4.3.1 Physical Network Interface

PatXfer RT supports the DICOM upper layer using TCP/IP. PatXfer RT is indifferent to the physical medium over which TCP/IP executes. It inherits this from the operating system upon which it executes.

4.3.2 Additional Protocols

The usage of DNS and DHCP is possible and is based on the network configuration of the operating system upon which PatXfer RT executes.

4.4 Configuration

4.4.1 AE Title / Presentation Address Mapping

Configuration of remote and local DICOM nodes can be performed with the graphical user interface of PatXfer RT.
PatXfer RT can configure several nodes representing remote QR Servers or Storage SCPs. On the corresponding settings page, application-wide global parameter and node-specific parameters can be entered.

4.4.1.1 Local AE Titles

The local AET for the Query/Retrieve SCU is an application-wide global parameter. The local AET for the Storage SCP defaults to the one of the Query/Retrieve SCU. But for each specified archive you may define an own Storage SCP AET.
The listening port is an application-wide global parameter.

Application Entity	Default AE Title	Default TCP/IP Port
PatXfer RT	PatXferRT	104

4.4.1.2 Remote AE Title/Presentation Address Mapping

In PatXfer RT you can specify several archives for import and export. The IP address/hostname, AET and listening port may be configured for each DICOM network archive separately within the Graphical User Interface.

4.4.2 Parameters

Additional a timeout may be specified for each DICOM network archive separately.

Parameter	Configurable	Default Value
Timeout	Yes	30
Maximum PDU Size	No	28672

5 Media Interchange

PatXfer RT supports DICOM media interchange for import and export of DICOM data:

- For import PatXfer RT supports media interchange application profiles. To reflect this the support for the Standard General Purpose CD-R Interchange is added to provide the supported SOP Classes. Nevertheless PatXfer RT is able to import DICOM files even without the existence of any DICOMDIR by scanning a given file system for any kind of DICOM files.

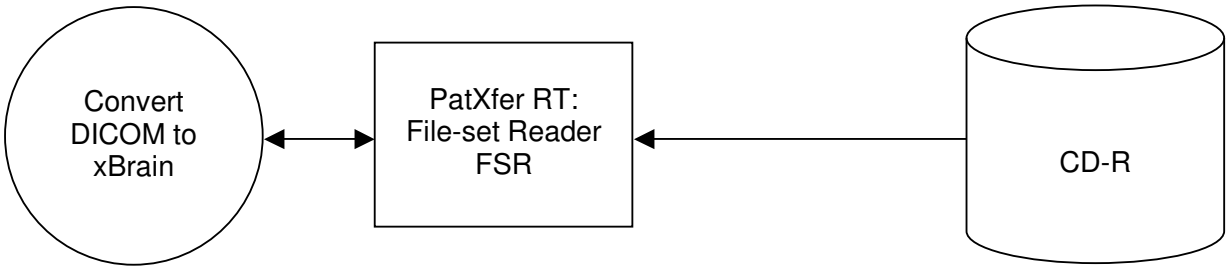
- For export there is no media interchange application profile supported. The files are simply stored to the file system grouped by patient without using any DICOMDIR. For export it supports the same SOP Classes like the Storage SCU (see Table 4-3 or Table 4-7).

5.1 Implementation Model

5.1.1 Application Data Flow Diagram

With PatXfer RT the user may browse DICOM File-sets, import selected entities and convert them to the BrainLAB advanced file format (xBrain).

The File System Reader:



5.1.2 Functional Definition of Application Entity (AE)

Some communications and data transfer with remote AE's are accomplished utilizing the file system provided by the operating system upon which PatXfer RT executes.

- File Set Reader:
  PatXfer RT loads DICOM data from the file system and converts it to the BrainLAB advanced file format (xBrain) – with user interaction. The reader supports the same SOP classes as the Storage SCP (see Table 4-3).

5.1.3 Sequencing Of Real World Activities

Not necessary.

5.1.4 File Meta Implementation Identifying Information

PatXfer RT provides the same information as in chapter 4.2.1.2.4.

5.2 Application Entity Specifications

5.2.1 PatXfer RT Specification

PatXfer RT supports the following Media Interchange Profiles:

AE Related Application Profiles, Real-World Activities, and Roles			
Supported APs	**Real World Activity**	**Roles**	**SC Option**
STD-GEN-CD	Convert DICOM to xBrain	FSR	Interchange

Table 5-1: Supported Media Interchange Profiles.

5.2.1.1 File Meta Information For The Application Entity

The Source Application Entity Title included in the File Meta Header is configurable. It is the same as the local AET of the network configuration (see chapter 4.4.1.1)

5.2.1.2 Real-World Activities

5.2.1.3 Activity – Convert DICOM to xBrain

PatXfer RT acts as an FSR using the Interchange option

- When requested to provide a directory listing it will read the File-set and display the DICOM-DIR directory entries for all SOP Instances in the File-set.
- When requested to load the selected entries from directory listing to convert them to xBrain, only those SOP Instances are loaded that correspond to the Application Profile STD-GEN-CD.
- For the list of Application Profiles that invoke this AE see Table 5-1. The supported SOP Classes see Table 4-3.

5.2.1.3.1 Media Storage Application Profiles

PatXfer supports the STD-GEN-CD Application Profile.

5.2.1.3.1.1 Options

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

SOP Classes	Transfer Syntaxes
All SOP Classes for SCPs listed in Table 4-3	All Transfer Syntaxes listed in Table 4-4

See chapter 8.1.2 for further information on acceptance of SOP Instances, i.e. whether PatXfer RT is able to import and convert the DICOM data.

5.3 Augmented And Private Application Profiles

PatXfer RT does not support any augmented or private application profiles.

5.4 Media Configuration

PatXfer RT uses the local AET configured for the network services as source AET for the DICOM files.

6 Support Of Extended Character Sets

PatXfer RT supports the

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

7 Security Profiles

No security profiles are supported.

8 Annexes

8.1 IOD Contents

8.1.1 Created SOP Instances

The following tables use a number of abbreviations. The abbreviations used in the “Presence of Module” column are:

MNAP	Module not always present
ALWAYS	Module always present

8.1.1.1 Created IODs

IE	Module	Reference	Presence of Module
Patient	Patient	Table 8-5	ALWAYS
Study	General Study	Table 8-6	ALWAYS
	Patient Study	Table 8-7	ALWAYS
Series	General Series	Table 8-8	ALWAYS
Frame of Reference	Frame of Reference	Table 8-9	ALWAYS
Equipment	General Equipment	Table 8-10	ALWAYS
Image	General Image	Table 8-11	ALWAYS
	Image Plane	Table 8-12	ALWAYS
	Image Pixel	Table 8-13	ALWAYS
	CT Image	Table 8-16	ALWAYS
	VOI LUT	Table 8-14	MNAP
	SOP Common	Table 8-15	ALWAYS

Table 8-1: CT Image Storage IOD

IE	Module	Reference	Presence of Module
Patient	Patient	Table 8-5	ALWAYS
Study	General Study	Table 8-6	ALWAYS
	Patient Study	Table 8-7	ALWAYS
Series	General Series	Table 8-8	ALWAYS
Frame of Reference	Frame of Reference	Table 8-9	ALWAYS
Equipment	General Equipment	Table 8-10	ALWAYS
Image	General Image	Table 8-11	ALWAYS
	Image Plane	Table 8-12	ALWAYS
	Image Pixel	Table 8-13	ALWAYS
	MR Image	Table 8-17	ALWAYS
	VOI LUT	Table 8-14	MNAP
	SOP Common	Table 8-15	ALWAYS

Table 8-2: MR Image Storage IOD

IE	Module	Reference	Presence of Module
Patient	Patient	Table 8-5	ALWAYS
Study	General Study	Table 8-6	ALWAYS
	Patient Study	Table 8-7	ALWAYS
Series	RT Series	Table 8-18	ALWAYS
Frame of Reference	Frame of Reference	Table 8-9	ALWAYS
Equipment	General Equipment	Table 8-10	ALWAYS
Plan	RT General Plan Module	Table 8-19	ALWAYS
	RT Beams Module	Table 8-20	ALWAYS
	SOP Common	Table 8-15	ALWAYS

Table 8-3: RT Plan Storage IOD

NOTE: The exported beam setup in the RT Beams Module holds dummy beams that are not usable for any patient treatment. The RT Plan is used only to export isocenters.

IE	Module	Reference	Presence of Module
Patient	Patient	Table 8-5	ALWAYS
Study	General Study	Table 8-6	ALWAYS
	Patient Study	Table 8-7	ALWAYS
Series	RT Series	Table 8-18	ALWAYS
Equipment	General Equipment	Table 8-10	ALWAYS
Structure Set	Structure Set	Table 8-21	ALWAYS
	ROI Contour	Table 8-22	ALWAYS
	RT ROI Observations	Table 8-23	ALWAYS
	SOP Common	Table 8-15	ALWAYS

Table 8-4: RT Structure Set Storage IOD

8.1.1.2 Created Modules

The following tables use a number of abbreviations. The abbreviations used in the “Presence” column are:

VNAP	Value not always present (attribute set to zero length if no value is present)
ANAP	Attribute not always present
ALWAYS	Attribute is always present
EMPTY	Attribute is set to zero length

The abbreviations used in the “Source” column:

USER	The attribute value source is from user input
AUTO	The attribute value is generated automatically
CONFIG	The attribute value source is a configurable parameter

8.1.1.2.1 Common Modules

Attribute Name	Tag	VR	Value	Presence	Source
Patient's Name	(0010,0010)	PN	From xBrain or user input	VNAP	AUTO/ USER
Patient ID	(0010,0020)	LO	From xBrain or user input	VNAP	AUTO/ USER
Patient's Birth Date	(0010,0030)	DA	From xBrain	VNAP	AUTO
Patient's Sex	(0010,0040)	CS	From xBrain	VNAP	AUTO

Table 8-5: Patient Module

Attribute Name	Tag	VR	Value	Presence	Source
Study Instance UID	(0020,000D)	UI	Generated	ALWAYS	AUTO
Study Date	(0008,0020)	DA	From xBrain	ANAP	AUTO
Referring Physician's Name	(0008,0090)	PN		EMPTY	AUTO
Study ID	(0020,0010)	SH	From xBrain	VNAP	AUTO
Accession Number	(0008,0050)	SH		EMPTY	AUTO
Study Description	(0008,1030)	LO	From xBrain	ANAP	AUTO

Table 8-6: General Study Module

Attribute Name	Tag	VR	Value	Presence	Source
Patient's Height	(0010,1020)	DS	From xBrain	ANAP	AUTO
Patient's Weight	(0010,1030)	DS	From xBrain	ANAP	AUTO

Table 8-7: Patient Study Module

Attribute Name	Tag	VR	Value	Presence	Source
Modality	(0008,0060)	CS	From xBrain	ALWAYS	AUTO
Series Instance UID	(0020,000E)	UI	Generated	ALWAYS	AUTO
Series Number	(0020,0011)	IS	From xBrain	ALWAYS	AUTO
Series Date	(0008,0021)	DA	From xBrain	ANAP	AUTO
Series Time	(0008,0031)	TM	From xBrain	ANAP	AUTO
Series Description	(0008,103E)	LO	From xBrain	ANAP	AUTO
Patient Position	(0018,5100)	DA	If applicable: from xBrain or user	EMPTY/ ALWAYS[1]	AUTO/ USER

Table 8-8: General Series Module

Attribute Name	Tag	VR	Value	Presence	Source
Frame of Reference UID	(0020,0052)	UI	Generated	ALWAYS	AUTO
Position Reference Indicator	(0020,1040)	LO		EMPTY	AUTO

Table 8-9: Frame of Reference Module

[1] For CT and MR Image Storage this attribute exists always, else it's not present.

Attribute Name	Tag	VR	Value	Presence	Source
Manufacturer	(0008,0070)	LO	“BrainLAB”	ALWAYS	AUTO
Station Name	(0008,1010)	SH	<Host Name>	ALWAYS	AUTO
Manufacturer's Model Name	(0008,1090)	LO	“PatXferRT”	ALWAYS	AUTO
Software Version(s)	(0018,1020)	LO	“1.0.0”	ALWAYS	AUTO
Private Creator Code	(0009,00xx)	LO	“BrainLAB_Conversion”	ALWAYS	AUTO
Export Platform Name	(0009,xx01)	LO	Configured Platform Name	ALWAYS	CONFIG

Table 8-10: General Equipment Module

Attribute Name	Tag	VR	Value	Presence	Source
Instance Number	(0020,0013)	IS	From xBrain	ALWAYS	AUTO
Content Date	(0008,0023)	DA	<Current Date>	ALWAYS	AUTO
Content Time	(0008,0033)	TM	<Current Time>	ALWAYS	AUTO

Table 8-11: General Image Module

Attribute Name	Tag	VR	Value	Presence	Source
Pixel Spacing	(0028,0030)	DS	From xBrain	ALWAYS	AUTO
Image Orientation (Patient)	(0020,0037)	DS	From xBrain	ALWAYS	AUTO
Image Position (Patient)	(0020,0032)	DS	From xBrain	ALWAYS	AUTO
Slice Thickness	(0018,0050)	DS	From xBrain	ALWAYS	AUTO

Table 8-12: Image Plane Module

Attribute Name	Tag	VR	Value	Presence	Source
Pixel Data	(7FE0,0010)	OB OW	From xBrain	ALWAYS	AUTO

Table 8-13: Image Pixel Module

Attribute Name	Tag	VR	Value	Presence	Source
Window Center	(0028,1050)	DS	From xBrain	ANAP	AUTO
Window Width	(0028,1051)	DS	From xBrain	ANAP	AUTO

Table 8-14: VOI LUT Module

Attribute Name	Tag	VR	Value	Presence	Source
SOP Class UID	(0008,0016)	DS	IOD specific	ALWAYS	AUTO
SOP Instance UID	(0008,0018)	DS	Generated	ALWAYS	AUTO
Specific Character Set	(0008,0005)	CS	“ISO_IR 100”	ALWAYS	AUTO
Instance Creation Date	(0008,0012)	DA	<Current Date>	ALWAYS	AUTO
Instance Creation Time	(0008,0013)	TM	<Current Time>	ALWAYS	AUTO

Table 8-15: SOP Common Module

8.1.1.2.2 CT Specific Modules

Attribute Name	Tag	VR	Value	Presence	Source
Image Type	(0008,0008)	CS	"DERIVED/SECONDARY/AXIAL"	ALWAYS	AUTO
Samples per Pixel	(0028,0002)	US	1	ALWAYS	AUTO
Photometric Interpretation	(0028,0004)	CS	"MONOCHROME2"	ALWAYS	AUTO
Rows	(0028,0010)	IS	From xBrain	ALWAYS	AUTO
Columns	(0028,0011)	DA	From xBrain	ALWAYS	AUTO
Bits Allocated	(0028,0100)	US	16	ALWAYS	AUTO
Bits Stored	(0028,0101)	US	16	ALWAYS	AUTO
High Bit	(0028,0102)	US	15	ALWAYS	AUTO
Pixel Representation	(0028,0103)	US	0000H *(unsigned integer)*	ALWAYS	AUTO
Rescale Intercept	(0028,1052)	DS	-1024	ALWAYS	AUTO
Rescale Slope	(0028,1053)	DS	1	ALWAYS	AUTO
KVP	(0018,0060)	DS		EMPTY	AUTO
Acquisition Number	(0020,0012)	IS		EMPTY	AUTO

Table 8-16: CT Image Module

8.1.1.2.3 MR Specific Modules

Attribute Name	Tag	VR	Value	Presence	Source
Image Type	(0008,0008)	CS	"DERIVED/SECONDARY/OTHER"	ALWAYS	AUTO
Samples per Pixel	(0028,0002)	US	1	ALWAYS	AUTO
Photometric Interpretation	(0028,0004)	CS	"MONOCHROME2"	ALWAYS	AUTO
Rows	(0028,0010)	IS	From xBrain	ALWAYS	AUTO
Columns	(0028,0011)	DA	From xBrain	ALWAYS	AUTO
Bits Allocated	(0028,0100)	US	16	ALWAYS	AUTO
Bits Stored	(0028,0101)	US	16	ALWAYS	AUTO
High Bit	(0028,0102)	US	15	ALWAYS	AUTO
Pixel Representation	(0028,0103)	US	0000H *(unsigned integer)*	ALWAYS	AUTO

Table 8-17: MR Image Module

8.1.1.2.4 RT Specific Modules

Attribute Name	Tag	VR	Value	Presence	Source
Modality	(0008,0060)	CS	“RTPLAN” or “RTSTRUCT”	ALWAYS	AUTO
Series Instance UID	(0020,000E)	UI	Generated	ALWAYS	AUTO
Series Number	(0020,0011)	IS	1	ALWAYS	AUTO
Series Description	(0008,103E)	LO	From xBrain	ANAP	AUTO

Table 8-18: RT Series Module

Attribute Name	Tag	VR	Value	Presence	Source
RT Plan Label	(300A,0002)	LO	From xBrain	ALWAYS	AUTO
RT Plan Name	(300A,0003)	SH	From xBrain	ANAP	AUTO
RT Plan Description	(300A,0004)	ST	From xBrain	ANAP	AUTO
Operators’ Name	(0008,1070)	PN		EMPTY	AUTO
RT Plan Date	(300A,0006)	DA	From xBrain	ALWAYS	AUTO
RT Plan Time	(300A,0007)	TM	From xBrain	ALWAYS	AUTO
RT Plan Geometry	(300A,000C)	CS	“PATIENT”	ALWAYS	AUTO
Referenced Structure Set Sequence	(300C,0060)	SQ		ALWAYS	AUTO
>Referenced SOP Class UID	(0008,1150)	UI	“1.2.840.10008.5.1.4.1.1.481.3”	ALWAYS	AUTO
>Referenced SOP Instance UID	(0008,1155)	UI	Generated	ALWAYS	AUTO

Table 8-19: RT General Plan Module

Attribute Name	Tag	VR	Value	Presence	Source
Beam Sequence	(300A,00B0)	SQ		ALWAYS	AUTO
>Beam Number	(300A,00C0)	IS	From xBrain	ALWAYS	AUTO
>Beam Type	(300A,00C4)	CS	“STATIC”	ALWAYS	AUTO
>Radiation Type	(300A,00C6)	CS		EMPTY	AUTO
>Treatment Machine Name	(300A,00B2)	SH	“DummyMachineName”	ALWAYS	AUTO
>Beam Limiting Device Sequence	(300A,00B6)	SQ	Two items	ALWAYS	AUTO
>>RT Beam Limiting Device Type	(300A,00B8)	CS	Dummy value: “X” and “Y”	ALWAYS	AUTO
>>Number of Leaf/Jaw Pairs	(300A,00BC)	IS	Dummy value: 1	ALWAYS	AUTO
>Number of Wedges	(300A,00D0)	IS	Dummy value: 0	ALWAYS	AUTO
>Number of Compensators	(300A,00E0)	IS	Dummy value: 0	ALWAYS	AUTO
>Number of Boli	(300A,00ED)	IS	Dummy value: 0	ALWAYS	AUTO
>Number of Blocks	(300A,00F0)	IS	Dummy value: 0	ALWAYS	AUTO
>Final Cumulative Meterset Weight	(300A,010E)	DS	Dummy value: 1	ALWAYS	AUTO
>Number of Control Points	(300A,0110)	IS	Dummy value: 2	ALWAYS	AUTO
>Control Point Sequence	(300A,0111)	SQ		ALWAYS	AUTO
>>Control Point Index	(300A,0112)	IS	Dummy value: 0 … 1	ALWAYS	AUTO
>>Cumulative Meterset Weight	(300A,0134)	DS	Dummy value: 0 … 1	ALWAYS	AUTO
>>Beam Limiting Device Position Sequence	(300A,011A)	SQ		ALWAYS	AUTO
>>>RT Beam Limiting Device Type	(300A,00B8)	CS	Dummy value: “X” or “Y”	ALWAYS	AUTO
>>>Leaf/Jaw Positions	(300A,011C)	DS	Dummy value: 0\0	ALWAYS	AUTO
>>Gantry Angle	(300A,011E)	DS	Dummy value: 0	ALWAYS	AUTO
>>Gantry Rotation Direction	(300A,011F)	CS	Dummy value: “NONE”	ALWAYS	AUTO
>>Beam Limiting Device Angle	(300A,0120)	DS	Dummy value: 0	ALWAYS	AUTO
>>Beam Limiting Device Rotation Direction	(300A,0121)	CS	Dummy value: “NONE”	ALWAYS	AUTO
>>Patient Support Angle	(300A,0122)	DS	Dummy value: 0	ALWAYS	AUTO
>>Patient Support Rotation Direction	(300A,0123)	CS	Dummy value: “NONE”	ALWAYS	AUTO
>>Table Top Eccentric Angle	(300A,0125)	DS	Dummy value: 0	ALWAYS	AUTO
>>Table Top Eccentric Rotation Direction	(300A,0126)	CS	Dummy value: “NONE”	ALWAYS	AUTO
>>Table Top Vertical Position	(300A,0128)	DS		EMPTY	AUTO
>>Table Top Longitudinal Position	(300A,0129)	DS		EMPTY	AUTO
>>Table Top Lateral Position	(300A,012A)	DS		EMPTY	AUTO
>>Isocenter Position	(300A,012C)	DS	From xBrain	ALWAYS	AUTO

Table 8-20: RT Beams Module

Attribute Name	Tag	VR	Value	Presence	Source
Referenced Frame of Reference Sequence	(3006,0010)	SQ	From xBrain: 1 … N frames	ALWAYS	AUTO
>Frame of Reference UID	(0020,0052)	UI		ALWAYS	AUTO
>Frame of Reference Relationship Sequence	(3006,00C0)	SQ	From xBrain: 1 … N related frames (rigid image fusion)	ALWAYS	AUTO
>>Related Frame of Reference UID	(3006,00C2)	UI		ALWAYS	AUTO
>>Frame of Reference Transformation Type	(3006,00C4)	CS	“HOMOGENEOUS”	ALWAYS	AUTO
>>Frame of Reference Transformation Matrix	(3006,00C6)	DS	From xBrain	ALWAYS	AUTO
>>Frame of Reference Transformation Comment	(3006,00C8)	LO		ALWAYS	AUTO
>RT Referenced Study Sequence	(3006,0012)	SQ	Contains 1 study reference	ALWAYS	AUTO
>>Referenced SOP Instance UID	(0008,1155)	UI		ALWAYS	AUTO
>>RT Referenced Series Sequence	(3006,0014)	SQ	1 … N series references (with same frame of reference)	ALWAYS	AUTO
>>>Series Instance UID	(0020,000E)	UI		ALWAYS	AUTO
>>>Contour Image Sequence	(3006,0016)	SQ	1 … N image references	ALWAYS	AUTO
>>>>Referenced SOP Instance UID	(0008,1155)	UI		ALWAYS	AUTO
>>>>Referenced SOP Class UID	(0008,1150)	UI		ALWAYS	AUTO
Structure Set ROI Sequence	(3006,0020)	SQ	From xBrain:1 … N ROIs	ALWAYS	AUTO
>ROI Number	(3006,0022)	IS	0 …N-1	ALWAYS	AUTO
>Referenced Frame of Reference UID	(3006,0024)	UI	From xBrain: 1 … N	ALWAYS	AUTO
>ROI Name	(3006,0026)	LO	From xBrain	ALWAYS	AUTO
>ROI Description	(3006,0028)	ST	From xBrain	VNAP	AUTO
>ROI Generation Algorithm	(3006,0036)	CS	From xBrain	VNAP	AUTO

Table 8-21: Structure Set Module

Attribute Name	Tag	VR	Value	Presence	Source
ROI Contour Sequence	(3006,0039)	SQ	From xBrain: 1 … N ROIs	ALWAYS	AUTO
>Referenced ROI Number	(3006,0084)	IS	0 … N-1	ALWAYS	AUTO
>ROI Display Color	(3006,002A)	IS	From xBrain	ALWAYS	AUTO
>Contour Sequence	(3006,0040)	SQ		ALWAYS	AUTO
>>Contour Image Sequence	(3006,0016)	SQ	Contains a single item if Contour Geometric Type is CLOSED_PLANAR	ANAP	AUTO
>>>Referenced SOP Class UID	(0008,1150)	UI		ALWAYS	AUTO
>>>Referenced SOP Instance UID	(0008,1155)	UI		ALWAYS	AUTO
>>Contour Geometric Type	(3006,0042)	CS	"CLOSED_PLANAR" for Voxel Objects; "POINT" for Isocenters (see ROI Interpreted Type)	ALWAYS	AUTO
>>Number of Contour Points	(3006,0046)	IS	From xBrain	ALWAYS	AUTO
>>Contour Data	(3006,0050)	DS	From xBrain	ALWAYS	AUTO

Table 8-22: ROI Contour Module

Attribute Name	Tag	VR	Value	Presence	Source
RT ROI Observations Sequence	(3006,0080)	SQ	Number of Isocenters plus number of ROI items	ALWAYS	AUTO
>Observation Number	(3006,0082)	IS	0 … N-1	ALWAYS	AUTO
>Referenced ROI Number	(3006,0084)	IS	0 … N-1	ALWAYS	AUTO
>RT ROI Interpreted Type	(3006,00A4)	CS	"ISOCENTER" if Contour Geometric Type contains POINT	ANAP	AUTO
>ROI Interpreter	(3006,00A6)	PN		EMPTY	AUTO

Table 8-23: RT ROI Observations Module

8.1.2 Usage Of Attributes From Received IOD's

This section describes the requirements on the DICOM data, which shall be converted into the BrainLAB advanced file format (xBrain). Conversion can be performed on the DICOM RT Plan and RT Structure Set and DICOM Images of type CT, MR, PET, CR, XA and RF.

8.1.2.1 Images

PatXfer accepts all images of the SOP Classes in Table 4-3, which meet the following requirements:

- Only single frame images are supported.
- Images with an attribute (0028,0030) Pixel Spacing containing different values for x and y distance[2] will be rejected.

[2] To be more precise: If the difference between both values is greater than 0.001 mm!

8.1.2.2 RT Plan

The RT Plan is used for receiving the isocenter coordinates and for referencing the RT Structure Set.

- An RT Plan without a reference to the RT Structure Set is not supported.
- The attribute (300A,000C) RT Plan Geometry must be “PATIENT”.
- The attributes (300A,00C2) Beam Name and (300A,00C3) Beam Description in the Beam Sequence are used to uniquely identify the isocenter.

8.1.2.3 RT Structure Set

The RT Structure Set is used to import the data of contour objects, for referencing images and to import RT Structure Set isocenters.

- A contour object is accepted if the attribute (3006,0042) Contour Geometric Type in the Contour Sequence contains “CLOSED_PLANAR”.
- An isocenter is accepted if the attribute (3006,0042) Contour Geometric Type in the Contour Sequence contains “POINT” and attribute (3006,00A4) ROI Interpreted Type in the RT ROI Observations Sequence contains “ISOCENTER”.
- Rigid image fusions will be evaluated.

8.2 Data Dictionary Of Private Attributes

The Private Attributes added to created SOP Instances are listed in the Table below. BrainLAB reserves blocks of private attributes in group 0009. Further details on usage of these private attributes are contained in Section 8.1.

Tag	Attribute Name	VR	VM
(0009,00xx)	Private Creator Code “BrainLAB_Conversion”	LO	1
(0009,xx01)	Export Platform Name	LO	1

Table 8-24: Data Dictionary Of Private Attributes

8.3 Coded Terminology And Templates

None supported.

8.4 Grayscale Image Consistency

Not supported.

8.5 Standard Extended/Specialized/Private Sop Classes

None supported.

8.6 Private Transfer Syntaxes

None supported.

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