BrainLAB

Technical Publication

DICOM Conformance Statement

iPlan RT Image 4.1

Document Revision 1

December 4, 2008

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1 Conformance Statement Overview

This is a conformance statement for the BrainLAB software iPlan RT Image. The main purpose of this software is to import and convert DICOM data to the BrainLAB advanced file format.

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.

What is not part of iPlan RT Image:

- iPlan RT Image itself has no permanent DICOM Storage SCP to receive data at any time. If you need this feature the BrainLAB Converting DICOM Service has to be installed (see [2]).

SOP Classes	User Of Service (SCU)	Provider Of Service (SCP)
Transfer		
Computed Radiography Image Storage	No	Yes
CT Image Storage	No	Yes
MR Image Storage	No	Yes
Secondary Capture (SC) Image Storage	No	Yes
Multi-frame Grayscale Byte Secondary Capture Image Storage	No	Yes
Multi-frame Grayscale Word Secondary Capture Image Storage	No	Yes
Multi-frame True Color Secondary Capture 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
Nuclear Medicine Image Storage	No	Yes
Raw Data Storage	No	Yes
Positron Emission Tomography 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 iPlan RT Image

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 iPlan RT Image

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3 Introduction

3.1 Revision History

Document Version	Date of Issue	Author	Description
1	December 4, 2008		Initial release for iPlan RT Image 4.1

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	Compact Disk
CD-R	Compact Disk Recordable
DVD	Digital Versatile Disc
FSC	File-Set Creator
FSU	File-Set Updater
FSR	File-Set Reader
HD	Hard Disk
IOD	(DICOM) Information Object Definition
ISO	International Standard Organization
MOD	Magneto Optical Disk
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 – 2006
[2] DICOM Conformance Statement Converting DICOM Service 1.0, BrainLAB, April 19, 2005

3.6 Contact

In case of any questions or any inconsistencies concerning this Conformance Statement please contact dicomrt@brainlab.com.

4 Networking

4.1 Implementation Model

The BrainLAB iPlan RT Image 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 a file system.
- An application to convert DICOM image data (X-Ray, CT, MR, PET, NM, SC) into the BrainLAB advanced file format.

4.1.1 Application Data Flow Diagram

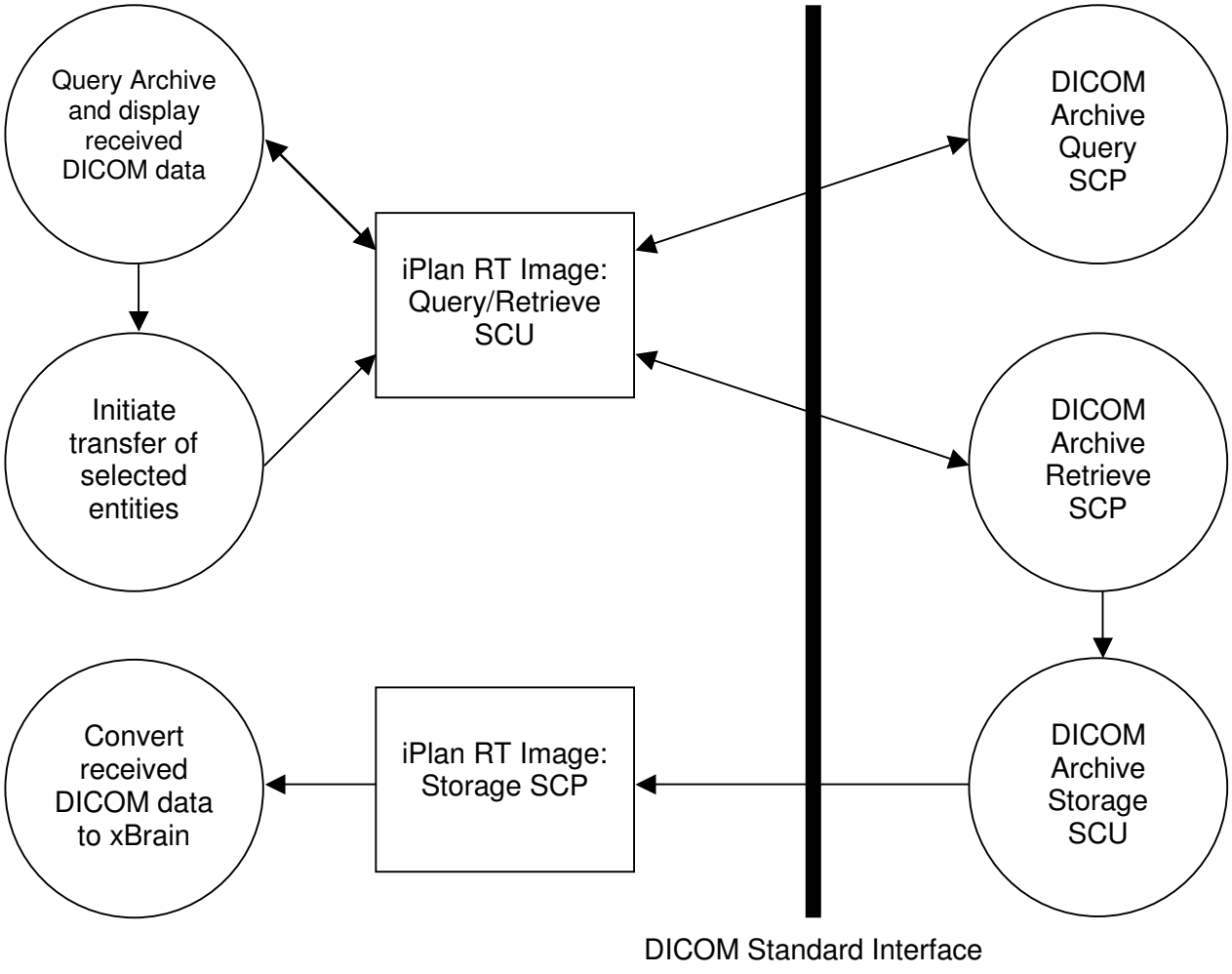

Figure 4-1: The Query/Retrieve SCU and Storage SCP application flow diagram

4.1.2 Functional Definition of Application Entity (AE)

Some communications and data transfer with remote AEs 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. iPlan RT Image 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[1]:
  During a move operation a DICOM Storage SCP is invoked. iPlan RT Image accepts an association with a Storage SCU negotiating any of the SOP Classes listed in Table 4-3. The received data may be – with user interaction – converted to the BrainLAB advanced file format.

[1] The Storage SCP is only available during a DICOM Query/Retrieve Move session. iPlan RT Image itself provides no permanent Storage SCP to receive data at any time. If you need this feature the BrainLAB Converting DICOM Service has to be installed (see [2])

4.1.3 Sequencing Of Real World Activities

iPlan RT Image 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 BrainLAB Advanced file format.

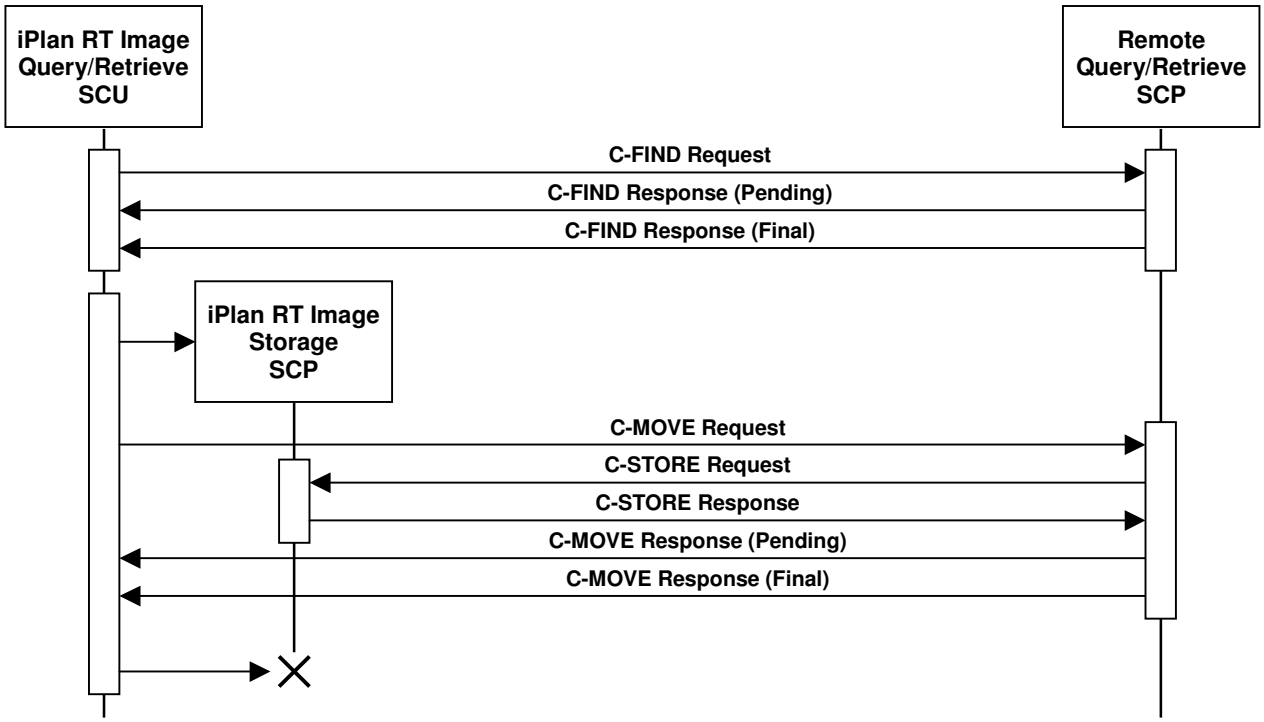

Figure 4-2: Sequencing of Query/Retrieve SCU and Storage SCP

4.2 Application Entity Specifications

4.2.1 IPlan RT Image Specification

4.2.1.1 SOP Classes and Transfer Syntaxes

iPlan RT Image 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

iPlan RT Image 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

iPlan RT Image imports DICOM image 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	No	Yes
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	No	Yes
Secondary Capture (SC) Image Storage	1.2.840.10008.5.1.4.1.1.7	No	Yes
Multi-frame Grayscale Byte 2ndary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.2	No	Yes
Multi-frame Grayscale Word 2ndary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.3	No	Yes
Multi-frame True Color 2ndary 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 (RF) 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
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	No	Yes

Table 4-3: Supported Storage SOP Classes

iPlan RT Image 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	SCU	SCP
DICOM Implicit VR Little Endian	1.2.840.10008.1.2	No	Yes
DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1	No	Yes
DICOM Explicit VR Big Endian	1.2.840.10008.1.2.2	No	Yes
JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14)	1.2.840.10008.1.2.4.70	No	Yes

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 iPlan RT Image 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	1.2.276.0.20.1.1.6.4.0.0
Implementation Version Name	iPlan RT Image

4.2.1.3 Association Initiation Policy

iPlan RT Image 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.

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 listed in Table 4-1 and all FIND SCU SOP Classes as listed in Table 4-2	All SCU Transfer Syntaxes as listed 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

iPlan RT Image 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
Patient's Name	(0010,0010)
Patient ID	(0010,0020)
Study Date	(0008,0020)
Accession Number	(0008,0050)

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 iPlan RT Image 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 listed in Table 4-1 and all SCU MOVE SOP Classes as listed in Table 4-2	All SCU Transfer Syntaxes as listed 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

iPlan RT Image 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 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 iPlan RT Image.

4.2.1.3.3.2 Proposed Presentation Contexts

Presentation Context Table			
Abstract Syntax	**Transfer Syntax**	**Role**	**Ext. Neg**
All SCU SOP Classes as listed in Table 4-1 and Table 4-3	All SCU Transfer Syntaxes as listed 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

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

See chapter 8.1.1 for further information on acceptance of SOP Instances, i.e. whether iPlan RT Image is able to import and convert the DICOM data.

4.2.1.4 Association Acceptance Policy

iPlan RT Image 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.

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 SCP SOP Classes as listed in Table 4-1 and Table 4-3	All SCP Transfer Syntaxes as listed 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

iPlan RT Image 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. 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

iPlan RT Image 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

iPlan RT Image supports the DICOM upper layer using TCP/IP. iPlan RT Image 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 iPlan RT Image 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 iPlan RT Image.
iPlan RT Image can configure several nodes representing remote Q/R Servers. 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 node 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
iPlanRTImage	iPlanRTImage	104

4.4.1.2 Remote AE Title/Presentation Address Mapping

In iPlan RT Image you can specify several nodes for import. The IP address/hostname, AET and listening port may be configured for each DICOM network node 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

iPlan RT Image supports DICOM media interchange for import of DICOM data:

- For import iPlan RT Image 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 iPlan RT Image is able to import DICOM files even without the existence of any DICOMDIR by scanning a given file system located on any media (e.g. HD, MOD, CD, DVD, Tapes) for any kind of DICOM files.

5.1 Implementation Model

5.1.1 Application Data Flow Diagram

With iPlan RT Image the user may browse DICOM File-sets, import selected entities and convert them to the BrainLAB advanced file format.

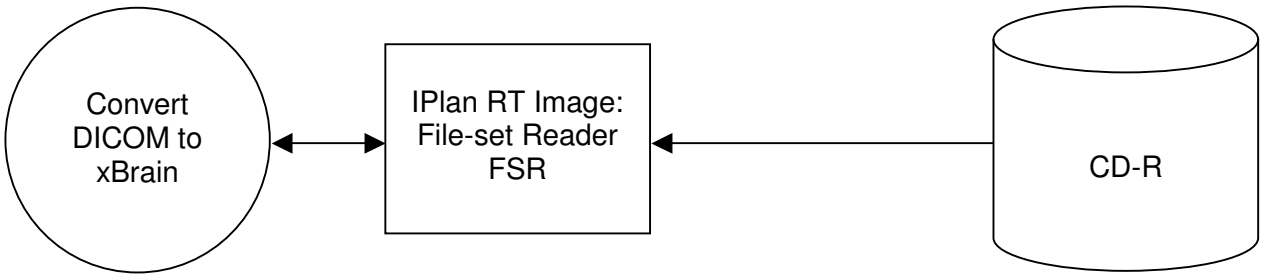

Figure 5-1: The media interchange application flow diagram

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 iPlan RT Image executes.

- File Set Reader:
  iPlan RT Image loads DICOM data from the file system and converts it to the BrainLAB advanced file format – 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

iPlan RT Image provides the same information as in chapter 4.2.1.2.4.

5.2 Application Entity Specifications

5.2.1 iPlan RT Image Specification

iPlan RT Image 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 BrainLAB data	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 BrainLAB Data

iPlan RT Image 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 BrainLAB Advanced file format, 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

iPlan RT Image 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 SCP SOP Classes listed in Table 4-3	All SCP Transfer Syntaxes listed in Table 4-4

See chapter 8.1.1 for further information on acceptance of SOP Instances, i.e. whether iPlan RT Image is able to import and convert the DICOM data.

5.3 Augmented And Private Application Profiles

iPlan RT Image does not support any augmented or private application profiles.

5.4 Media Configuration

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

6 Support Of Extended Character Sets

iPlan RT Image 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 Usage Of Attributes From Received IODs

This section describes the requirements on the DICOM data, which shall be converted into BrainLAB data. Conversion can be performed on the DICOM Images of type CT, MR, PET, NM, CR, XA, RF, and secondary captures.

8.1.1.1 Images

iPlan RT Image accepts all images of the SOP Classes in Table 4-3. Though, there are some restrictions and special conversions:

- Images with an attribute (0028,0030) Pixel Spacing containing different values for x and y distance[2] will be ignored.
- MR Images containing the entry “MOSAIC” in (0008,0008) Image Type will be split into several images according to the mosaic matrix in the header. If no valid mosaic matrix can be determined the image will be left unchanged.

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

8.2 Data Dictionary Of Private Attributes

None supported.

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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