

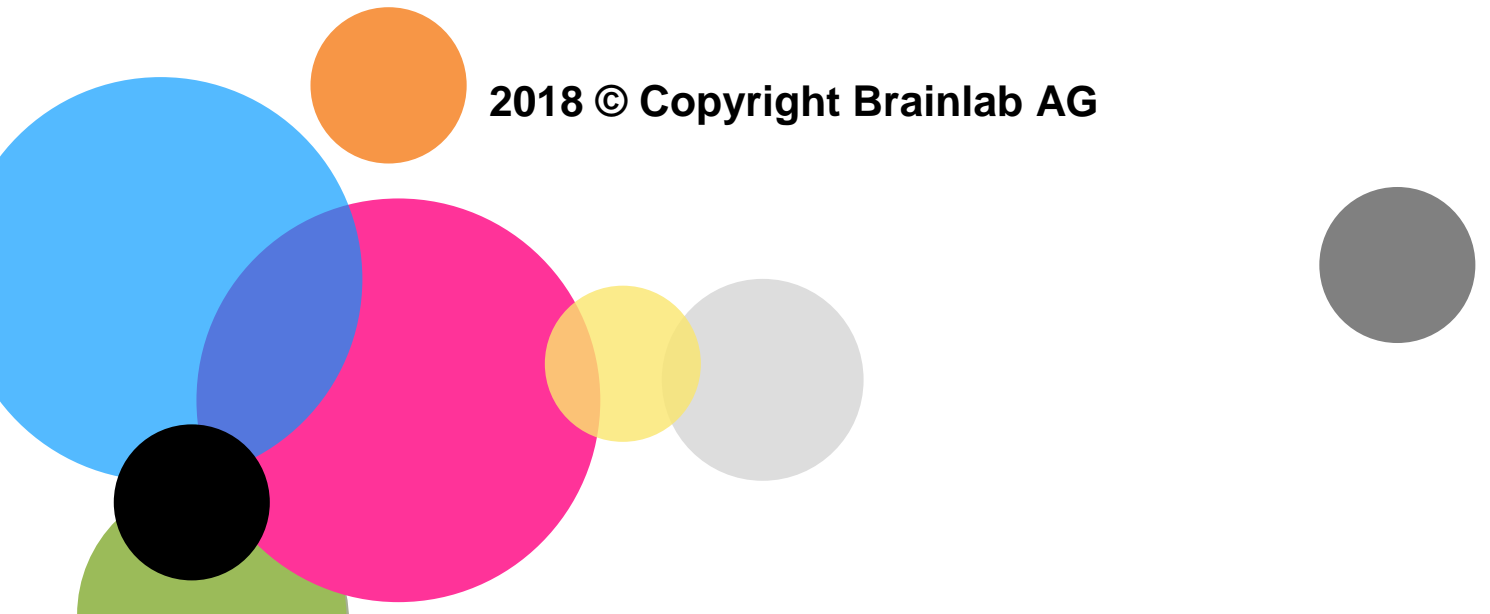
DICOM Conformance Statement

ExacTrac 6.5

Document Revision 4

July 21 ,2017

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1 Conformance Statement Overview

This is a conformance statement for the Brainlab software ExacTrac.

The DICOM import part of the application is

- 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).

What is not part of ExacTrac:

- There is no direct way e.g. to read DICOM files and send them to a remote system.
- ExacTrac itself has no permanent DICOM Storage SCP to receive data at any time. This feature is provided by the Brainlab DICOM Proxy (see [2]).

SOP Classes	User Of Service (SCU)	Provider Of Service (SCP)
Transfer		
CT Image Storage	No	Yes
RT Structure Set Storage	No	Yes
RT Plan Storage	No	Yes
RT Image Storage	Yes	No
Spatial Registration Storage	Yes	No
Query/Retrieve		
Study Root Query/Retrieve Information Model - FIND	Yes	No
Study Root Query/Retrieve Information Model - MOVE	Yes	No

Table 1-1: Network services supported by ExacTrac

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3 Introduction

3.1 Revision History

Document Version	Date of Issue	Author	Description
1	November 11, 2011		Initial release for ExacTrac 6
2	July 25, 2014		Update for ExacTrac 6.1
3	May 18, 2016		Update for ExacTrac 6.2
4	February 8, 2018		Update for ExacTrac 6.5

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
TPS	Treatment Planning System

3.5 References

- [1] Digital Imaging and Communications in Medicine (DICOM) 3.0, NEMA PS 3.1-3.18 – 2016
- [2] DICOM Conformance Statement DICOM Proxy, Brainlab AG

4 Networking

4.1 Implementation Model

The Brainlab ExacTrac application is an implementation of:

- A Media File Set Reader to load DICOM data from a file system.
- A Storage SCU that sends DICOM data to a DICOM archive or workstation.
- A Query/Retrieve SCU to query DICOM archives and to initiate a move request for the queried archive.

4.1.1 Application Data Flow Diagram

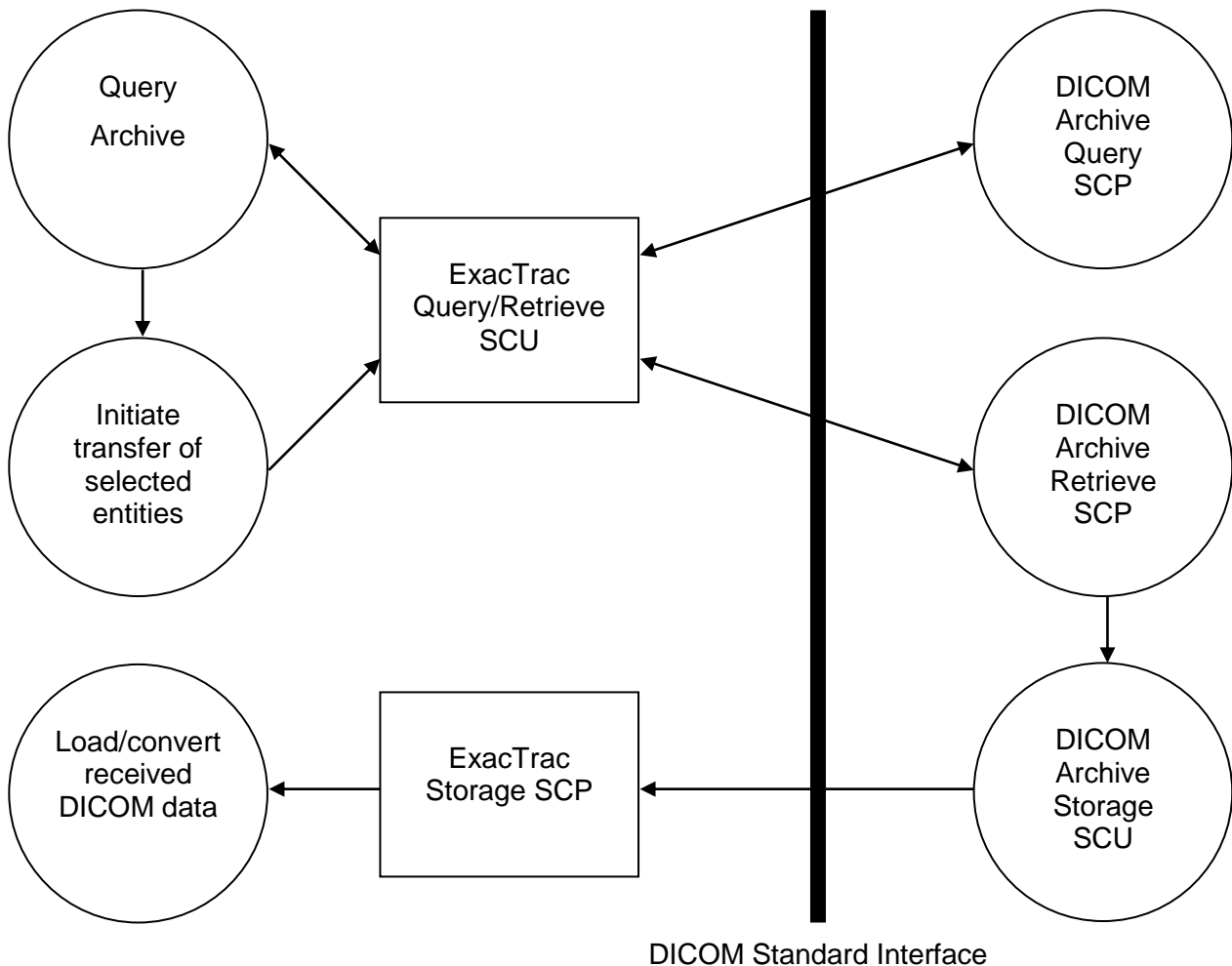


Figure 4-1: The Query/Retrieve SCU and Storage SCP application flow diagram

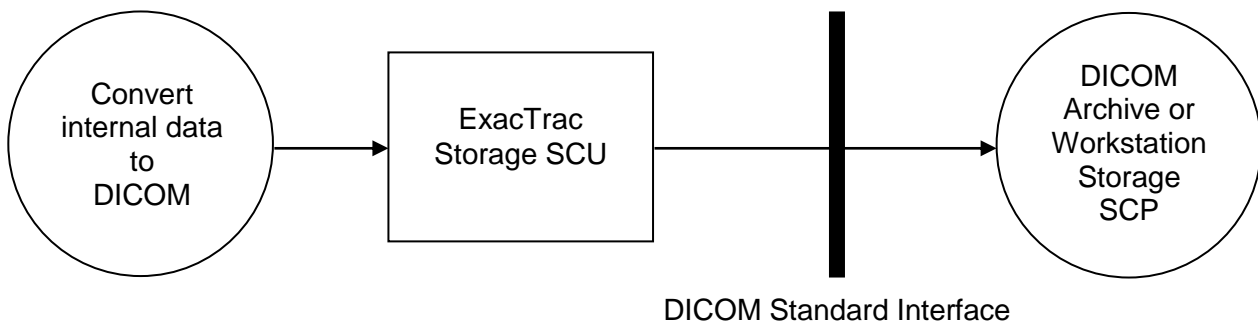


Figure 4-2: The Storage SCU application flow diagram

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 application wants to find a certain dataset in a DICOM archive. ExacTrac initiates an association as a Q/R SCU negotiating all models. The find request can be performed (depending on the negotiated models) on the DICOM levels study, series or instance. For a selected DICOM entity (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 SCP¹:**
During a move operation a DICOM Storage SCP is invoked. ExacTrac accepts an association with a Storage SCU negotiating any of the SOP Classes listed in Table 4-2.
- **Storage SCU:**
ExacTrac loads data from the Brainlab file format, converts it to DICOM and initiates an association with a Storage SCP negotiating all SOPs listed in Table 4-2. The converted DICOM data is then sent to the remote DICOM Storage SCP.

4.1.3 Sequencing Of Real World Activities

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

1. Query Archive:
 - a. Send DICOM Query/Retrieve C-FIND request.
 - b. Receive DICOM Query/Retrieve C-FIND responses.
2. Application selects data to retrieve.
3. Transfer of selected entities is initiated:
 - 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.

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

- d. Receive DICOM Query/Retrieve C-MOVE responses
- e. Stop the DICOM Storage SCP
- 4. Convert received DICOM data to Brainlab Advanced file format.

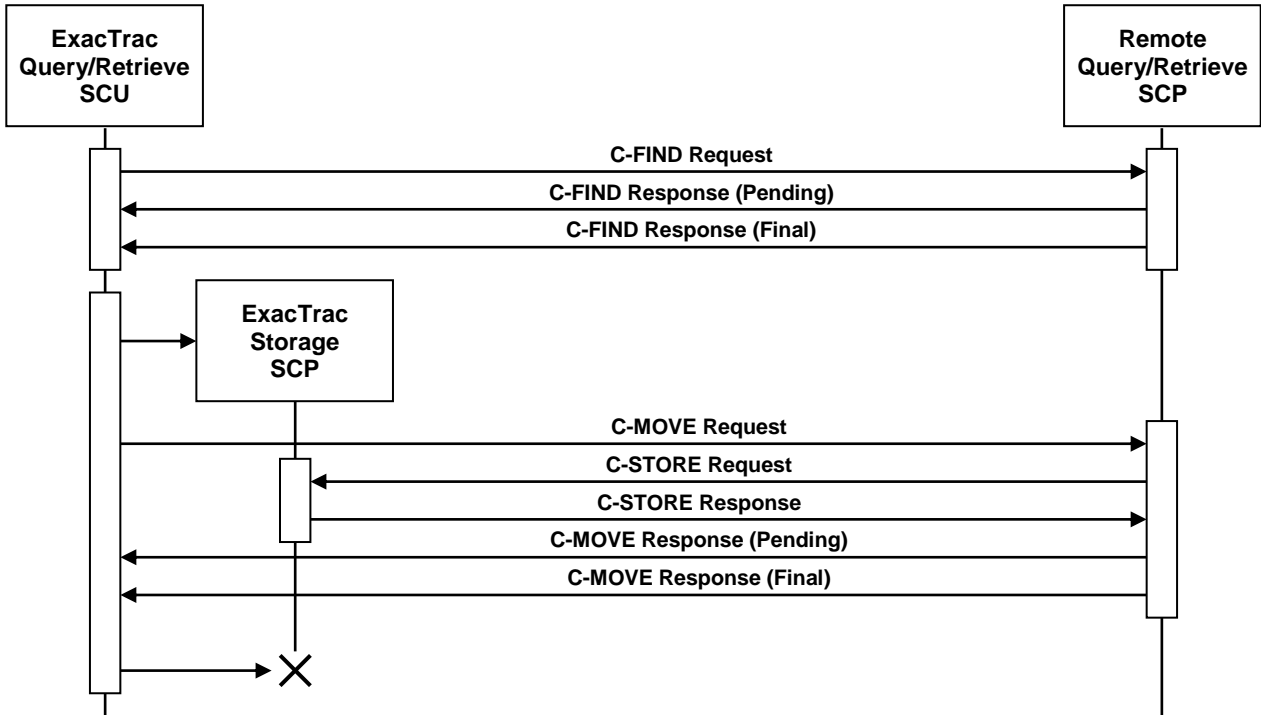


Figure 4-3: Sequencing of Query/Retrieve SCU and Storage SCP

4.2 Application Entity Specifications

4.2.1 ExacTrac Specification

4.2.1.1 SOP Classes and Transfer Syntaxes

ExacTrac 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

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

SOP Class Name	SOP Class UID	SCU	SCP
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	No	Yes
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	No	Yes
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	No	Yes
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	Yes	No
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1	Yes	No

Table 4-2: Supported Storage SOP Classes

ExacTrac 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
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

Table 4-3: Supported Query/Retrieve SOP Classes

ExacTrac 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	Extended Negotiation
DICOM Implicit VR Little Endian	1.2.840.10008.1.2	Yes	Yes	None
DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1	Yes	Yes	None
DICOM Explicit VR Big Endian	1.2.840.10008.1.2.2	Yes	Yes	None

Table 4-4: Supported Transfer Syntaxes (association negotiation)

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 ExacTrac 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	1.2.276.0.20.1.1.11.6.2.0
Implementation Version Name	ExacTrac

4.2.1.3 Association Initiation Policy

ExacTrac initiates an association in these cases:

1. Find: The application tries to find a specific entity in a remote DICOM archive.
2. Retrieve: The application wants to retrieve a specific entity from the remote DICOM archive and wants to convert it to the Brainlab advanced file format.
3. Store: The user wants to send image registration information 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 listed in Table 4-1 and all FIND SCU SOP Classes as listed in Table 4-3	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

ExacTrac 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 study-root model, the application restricts the patient/study query by the following attributes:

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

4.2.1.3.2 Activity – Retrieve

4.2.1.3.2.1 Description and Sequencing of Activities

On a successful find operation for a specific instance the application will automatically perform a move request. The storage target for receiving the DICOM data (the AET with which the move-request is equipped) is the ExacTrac 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 4-3	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

ExacTrac 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 ExacTrac.

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 4-2	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 SOP Specific Conformance

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

4.2.1.4 Association Acceptance Policy

ExacTrac accepts an association in this case:

1. Retrieve: The application wants to retrieve a specific entity from the remote DICOM archive.

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 4-2	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

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

4.2.1.4.1.4 Presentation Context Acceptance Criterion

ExacTrac 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

ExacTrac supports the DICOM upper layer using TCP/IP. ExacTrac 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 ExacTrac executes.

4.4 Configuration

4.4.1 AE Title / Presentation Address Mapping

Configuration of remote and local DICOM nodes can be performed in the export configuration settings of ExacTrac.

ExacTrac can configure several nodes representing Storage SCPs, but only one representing a remote Q/R Server.

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
ExacTrac	EXACTRAC	104

4.4.1.2 Remote AE Title/Presentation Address Mapping

In ExacTrac you can specify several nodes for export. The IP address/hostname, AET and listening port may be configured for each DICOM network node separately.

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	64234

5 Media Interchange

ExacTrac does not support DICOM media interchange.

For import ExacTrac scans a given file system located on any media (e.g. HD, MOD, CD, DVD, Tapes) for any kind of DICOM files.

For export the files are simply stored to the file system, grouped by patient. For both cases the supported SOP Classes are as defined in Table 4-2 for SCU or SCP respectively.

6 Support of Extended Character Sets

ExacTrac 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 Supported IODs

8.1.1.1 Imported IODs

8.1.1.1.1 Computed Tomography Image

IE	Module	Reference	Support
Patient	Patient	Table 8-6	
	Clinical Trial Subject	-	Not supported
Study	General Study	Table 8-7	
	Patient Study	Table 8-8	
	Clinical Trial Study	-	Not supported
Series	General Series	Table 8-9	
	Clinical Trial Series	-	Not supported
Frame of Reference	Frame of Reference	Table 8-11	
Equipment	General Equipment	Table 8-12	
Image	General Image	Table 8-13	
	Image Plane	Table 8-18	
	Image Pixel	Table 8-14	
	Device	Table 8-14	
	CT Image	Table 8-17	
	VOI LUT	Table 8-15	
	SOP Common	Table 8-16	

Table 8-1: CT Image Storage IOD

8.1.1.1.2 RT Structure Set

IE	Module	Reference	Support
Patient	Patient	Table 8-6	
	Clinical Trial Subject	-	Not supported
Study	General Study	Table 8-7	
	Patient Study	Table 8-8	
	Clinical Trial Study	-	Not supported
Series	RT Series	Table 8-10	
	Clinical Trial Series	-	Not supported
Equipment	General Equipment	Table 8-12	
Structure Set	Structure Set	Table 8-20	
	ROI Contour	Table 8-21	
	RT ROI Observations	Table 8-22	
	Approval	-	Not supported
	SOP Common	Table 8-16	

Table 8-2: RT Structure Set Storage IOD

8.1.1.1.3 RT Plan

IE	Module	Reference	Support
Patient	Patient	Table 8-6	
	Clinical Trial Subject	-	Not supported
Study	General Study	Table 8-7	
	Patient Study	Table 8-8	
	Clinical Trial Study	-	Not supported
Series	RT Series	Table 8-10	
	Clinical Trial Series	-	Not supported
Frame of Reference	Frame of Reference	Table 8-11	
Equipment	General Equipment	Table 8-12	
Plan	RT General Plan Module	Table 8-24	
	RT Prescription Module	Table 8-25	
	RT Tolerance Tables	-	Not supported
	RT Patient Setup	Table 8-26	
	RT Fraction Scheme	Table 8-27	
	RT Beams Module	Table 8-28	
	Approval	-	Not supported
	SOP Common	Table 8-16	

Table 8-3: RT Plan Storage IOD
8.1.1.2 Exported IODs
8.1.1.2.1 RT Image Storage

IE	Module	Reference	Support
Patient	Patient	Table 8-6	
	Clinical Trial Subject	-	Not supported
Study	General Study	Table 8-7	
	Patient Study	Table 8-8	
	Clinical Trial Study	-	Not supported
Series	RT Series	Table 8-10	
	Clinical Trial Series	-	Not supported
Frame of Reference	Frame of Reference	Table 8-11	
Equipment	General Equipment	Table 8-12	
Image	General Image	Table 8-13	
	Image Pixel	Table 8-14	
	RT Image	Table 8-29	
	VOI LUT	Table 8-15	
	SOP Common	Table 8-16	

Table 8-4: RT Image Storage IOD
8.1.1.2.2 Spatial Registration

IE	Module	Reference	Support
Patient	Patient	Table 8-6	
	Clinical Trial Subject	-	Not supported
Study	General Study	Table 8-7	
	Patient Study	Table 8-8	Not supported
	Clinical Trial Study	-	Not supported

IE	Module	Reference	Support
Series	General Series	Table 8-9	
	Clinical Trial Series	-	Not supported
Frame of Reference	Frame of Reference	Table 8-11	
Equipment	General Equipment	Table 8-12	
Registration	Spatial Registration	Table 8-30	
	Common Instance Reference	Table 8-31	
	SOP Common	Table 8-16	

Table 8-5: Registration IOD

8.1.2 Supported Modules

8.1.2.1 Imported/Exported Modules

8.1.2.1.1 Patient

Attribute Name	Tag	VR	Import	Export
Patient's Name	0010,0010	PN	Used to create internal patient information	From internal patient information
Patient ID	0010,0020	LO	Used to create internal patient information	From internal patient information
Patient's Birth Date	0010,0030	DA		From imported DICOM data
Patient's Sex	0010,0040	CS		From imported DICOM data

Table 8-6: Patient Module

8.1.2.1.2 General Study

Attribute Name	Tag	VR	Import	Export
Study Instance UID	0020,000D	UI		From imported DICOM data
Study Date	0008,0020	DA		From imported DICOM data
Referring Physician's Name	0008,0090	PN		From imported DICOM data
Study ID	0020,0010	SH		From imported DICOM data
Study Description	0008,1030	LO		From imported DICOM data

Table 8-7: General Study Module

8.1.2.1.3 Patient Study

Attribute Name	Tag	VR	Import	Export
Patient's Height	0010,1020	DS		
Patient's Weight	0010,1030	DS		

Table 8-8: Patient Study Module

8.1.2.1.4 General Series

Attribute Name	Tag	VR	Import	Export
Modality	0008,0060	CS		
Series Instance UID	0020,000E	UI		
Series Number	0020,0011	IS		
Series Date	0008,0021	DA		Creation Date
Series Time	0008,0031	TM		Creation Time
Series Description	0008,103E	LO		
Patient Position	0018,5100	DA	Prone and supine orientations only.	

Table 8-9: General Series Module

8.1.2.1.5 RT Series Module

Attribute Name	Tag	VR	Import	Export
Modality	0008,0060	CS	Only "RTPLAN" or "RTSTRUCT"	"RTIMAGE"
Series Instance UID	0020,000E	UI		
Series Number	0020,0011	IS		

Series Description	0008,103E	LO		
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Table 8-10: RT Series Module

8.1.2.1.6 Frame Of Reference

Attribute Name	Tag	VR	Import	Export
Frame of Reference UID	0020,0052	UI	If not provided in RTPLAN then RTSTRUCT must have a single CT referenced (frame of reference).	
Position Reference Indicator	0020,1040	LO		

Table 8-11: Frame of Reference Module

8.1.2.1.7 General Equipment

Attribute Name	Tag	VR	Import	Export
Manufacturer	0008,0070	LO		"Brainlab AG"
Station Name	0008,1010	SH		<Host Name>
Manufacturer's Model Name	0008,1090	LO		"ExacTrac"
Software Version(s)	0018,1020	LO		The current ExacTrac version

Table 8-12: General Equipment Module

8.1.2.1.8 General Image

Attribute Name	Tag	VR	Import	Export
Instance Number	0020,0013	IS		
Content Date	0008,0023	DA		
Content Time	0008,0033	TM		
Referenced Image Sequence	0008,1140	SQ		
>Include 'Image SOP Instance Reference Macro' Table 10-3				Includes reference to "Other image of stereoscopic pair"

Table 8-13: General Image Module

8.1.2.1.9 Image Pixel

Attribute Name	Tag	VR	Import	Export
Rows	0028,0010	IS		
Columns	0028,0011	DA		
Pixel Data	7FE0,0010	OB OW		

Table 8-14: Image Pixel Module

8.1.2.1.10 VOI LUT

Attribute Name	Tag	VR	Import	Export
Window Center	0028,1050	DS		
Window Width	0028,1051	DS		

Table 8-15: VOI LUT Module

8.1.2.1.11 SOP Common

Attribute Name	Tag	VR	Import	Export
SOP Class UID	0008,0016	DS		IOD specific
SOP Instance UID	0008,0018	DS		Generated
Specific Character Set	0008,0005	CS		"ISO_IR 100"
Instance Creation Date	0008,0012	DA		<Current Date>
Instance Creation Time	0008,0013	TM		<Current Time>

Table 8-16: SOP Common Module

8.1.2.2 Imported Modules

8.1.2.2.1 CT Image

Attribute Name	Tag	VR	Import
Image Type	0008,0008	CS	If type is LOCALIZED Device Sequence is parsed for Localizer Definitions.
Samples per Pixel	0028,0002	US	
Photometric Interpretation	0028,0004	CS	
Bits Allocated	0028,0100	US	
Bits Stored	0028,0101	US	
High Bit	0028,0102	US	
Pixel Representation	0028,0103	US	
Rescale Intercept	0028,1052	DS	
Rescale Slope	0028,1053	DS	
KVP	0018,0060	DS	
Acquisition Number	0020,0012	IS	

Table 8-17: CT Image Module

8.1.2.2.2 Image Plane

Attribute Name	Tag	VR	Import
Pixel Spacing	0028,0030	DS	Pixels must be square.
Image Orientation (Patient)	0020,0037	DS	Axial orientation must not be more than 3° angulated if image type is not LOCALIZED.
Image Position (Patient)	0020,0032	DS	CT scan length within 1024 mm and up to 400 images.
Slice Thickness	0018,0050	DS	

Table 8-18: Image Plane Module

8.1.2.2.3 Device

Attribute Name	Tag	VR	Import
Device Sequence	0050,0010	SQ	
>Include 'Code Sequence Macro'			Baseline CID 4051 (see chapter 8.3 for details)
>Device ID	0018,1003	LO	Only LOC_BL_HN is supported if Code Meaning is Localizer.
>Device Description	0050,0020	LO	

Table 8-19: Device Module

8.1.2.2.4 Structure Set Module

Attribute Name	Tag	VR	Import
Structure Set Label	3006,0002	SH	
Structure Set Name	3006,0004	LO	
Structure Set Description	3006,0006	ST	
Instance Number	0020,0013	IS	
Structure Set Date	3006,0008	DA	
Structure Set Time	3006,0009	TM	
Referenced Frame of Reference Sequence	3006,0010	SQ	Only one item is permitted in this sequence if no Frame of Reference is specified by RTPLAN.
>Frame of Reference UID	0020,0052	UI	
>RT Referenced Study Sequence	3006,0012	SQ	

Attribute Name	Tag	VR	Import
>>Referenced SOP Class UID	0008,1150	UI	Must reference the SOP Class for image modality CT.
>>Referenced SOP Instance UID	0008,1155	UI	
>>RT Referenced Series Sequence	3006,0014	SQ	
>>Series Instance UID	0020,000E	UI	
>>>Contour Image Sequence	3006,0016	SQ	
>>>>Referenced SOP Class UID	0008,1150	UI	
>>>>Referenced SOP Instance UID	0008,1155	UI	
Structure Set ROI Sequence	3006,0020	SQ	At least one and up to 48 ROIs are permitted in this sequence. Maximum number of ROIs is configurable. Interpreted Type is evaluated to prioritize import of certain ROIs.
>ROI Number	3006,0022	IS	
>Referenced Frame of Reference UID	3006,0024	UI	
>ROI Name	3006,0026	LO	Only the first 22 characters are displayed.
>ROI Volume	3006,002C	DS	
>ROI Generation Algorithm	3006,0038	CS	

Table 8-20: Structure Set Module

8.1.2.2.5 ROI Contour Module

Attribute Name	Tag	VR	Import
ROI Contour Sequence	3006,0039	SQ	
>Referenced ROI Number	3006,0084	IS	
>ROI Display Color	3006,002A	IS	
>Contour Sequence	3006,0040	SQ	
>>Contour Number	3006,0048	IS	
>>Contour Image Sequence	3006,0016	SQ	
>>>Referenced SOP Class UID	0008,1150	UI	Must be "1.2.840.10008.5.1.4.1.1.2"
>>>Referenced SOP Instance UID	0008,1155	UI	
>>Contour Geometric Type	3006,0042	CS	Only "CLOSED_PLANAR" is supported
>>Contour Offset Vector	3006,0045	DS	If value is provided it must 0.0.
>>Number of Contour Points	3006,0046	IS	
>>Contour Data	3006,0050	DS	Distance of contour data to referenced CT image must less than 0.1 mm or must be within half slice thickness if slice thickness is provided.

Table 8-21: ROI Contour Module

8.1.2.2.6 ROI Observations Module

Attribute Name	Tag	VR	Import
RT ROI Observations Sequence	3006,0080	SQ	

Attribute Name	Tag	VR	Import
>Observation Number	3006,0082	IS	
>Referenced ROI Number	3006,0084	IS	
>RT ROI Interpreted Type	3006,00A4	CS	ROIs of type "EXTERNAL" are by default not imported. Further exclude types can be configured. ROIs of types "PTV", "AVOIDANCE", "CTV", "ORGAN" are by default imported prioritized. Further types can be configured.
>ROI Interpreter	3006,00A6	PN	

Table 8-22: RT ROI Observations Module

8.1.2.2.7 Approval Module

Attribute Name	Tag	VR	Import
Approval Status	300E,0002	CS	Only if the status is APPROVED all of the following attributes must be available: Review Date, Review Time and Reviewer Name so that the approval status is displayed in the patient case comment.
Review Date	300E,0004	DA	
Review Time	300E,0005	TM	
Reviewer Name	300R,0008	PN	

Table 8-23: Approval Module

8.1.2.2.8 RT General Plan Module

Attribute Name	Tag	VR	Import
RT Plan Label	300A,0002	LO	Used for plan identification in patient case comment.
RT Plan Name	300A,0003	SH	Used for plan identification in patient case comment if RT Plan Label is empty.
RT Plan Description	300A,0004	ST	
Instance Number	0020,0013	IS	
Operators' Name	0008,1070	PN	
RT Plan Date	300A,0006	DA	
RT Plan Time	300A,0007	TM	
Plan Intent	300A,000A	CS	Not used.
RT Plan Geometry	300A,000C	CS	Geometry must be "PATIENT".
Referenced Structure Set Sequence	300C,0060	SQ	
>Referenced SOP Class UID	0008,1150	UI	
>Referenced SOP Instance UID	0008,1155	UI	
Referenced RT Plan Sequence	300C,0002	SQ	(see Note 8-1)
>Referenced SOP Class UID	0008,1150	UI	
>Referenced SOP Instance UID	0008,1155	UI	
>RT Plan Relationship	300A,0055	CS	(see Note 8-1)
>Private Creator Code	300B,00xx	LO	Brainlab - ONC - Beam Parameters
>Referenced Beam List	300B,xx10	IS	

Table 8-24: RT General Plan Module

Note 8-1: ExacTrac supports only one conceptual plan in one plan instance. In case a conceptual plan is split into several instances, ExacTrac also supports the Defined Term "EQUIVALENT". This way, several equivalent plans can be listed in the Referenced RT Plan Sequence (which may be linked to each other using the standard term CONCURRENT) in order to describe that these concurrent plans in total equal a single treatment plan instance.

8.1.2.2.9 RT Prescription Module

Attribute Name	Tag	VR	Import
Dose Reference Sequence	300A,0010	SQ	
>Dose Reference Number	300A,0022	IS	
>Dose Reference Structure Type	300A,0014	CS	
>Dose Reference Description	300A,0016	ST	
>Referenced ROI Number	3006,0084	IS	For automatic isocenter PTV assignment to find ROI in RTSTRUCT.
>Dose Reference Type	300A,0020	CS	Not used.

Table 8-25: RT Prescription Module

8.1.2.2.10 RT Patient Setup Module

Attribute Name	Tag	VR	Import
Patient Setup Sequence	300A,0180	SQ	
>Patient Setup Number	300A,0182	IS	
>Patient Setup Label	300A,0183	LO	Not used.
>Patient Position	0018,5100	CS	Only head-first orientations are allowed.

Table 8-26: RT Patient Setup Module

8.1.2.2.11 RT Fraction Scheme Module

Attribute Name	Tag	VR	Import
Fraction Group Sequence	300A,0070	SQ	
>Fraction Group Number	300A,0071	IS	
>Referenced Dose Reference Sequence	300C,0050	SQ	
>>Referenced Dose Reference Number	300C,0051	IS	Used to assign isocenter positions to target volumes.
>Number of Beams	300A,0080	IS	
>Referenced Beam Sequence	300C,0004	SQ	
>>Referenced Beam Number	300C,0006	IS	

Table 8-27: RT Fraction Scheme Module

8.1.2.2.12 RT Beams Module

Attribute Name	Tag	VR	Import
Beam Sequence	300A,00B0	SQ	
>Beam Number	300A,00C0	IS	
>Beam Name	300A,00C2	LO	Used to identify isocenters from 3rd party TPS.

Attribute Name	Tag	VR	Import
>Beam Description	300A,00C3	LO	Used to identify isocenters from iPlan RT TPS of Brainlab
>Beam Type	300A,00C4	CS	
>Radiation Type	300A,00C6	CS	Not used.
>Treatment Machine Name	300A,00B2	SH	
>Manufacturer	0008,0070	LO	
>Institution Name	0008,0080	LO	
>Institutional Department Name	0008,1040	LO	
>Manufacturer's Model Name	0008,1090	LO	
>Primary Dosimeter Unit	300A,00B3	CS	Not used.
>Source-Axis Distance	300A,00B4	DS	
>Beam Limiting Device Sequence	300A,00B6	SQ	
>>RT Beam Limiting Device Type	300A,00B8	CS	
>>Number of Leaf/Jaw Pairs	300A,00BC	IS	
>>Leaf Position Boundaries	300A,00BE	DS	
>Referenced Patient Setup Number	300C,006A	IS	
>Treatment Delivery Type	300A,00CE	CS	For automatic isocenter PTV assignment only "TREATMENT" beams are used.
>Number of Wedges	300A,00D0	IS	
>Number of Blocks	300A,00F0	IS	
>Number of Compensators	300A,00E0	IS	
>Number of Boli	300A,00ED	IS	
>Final Cumulative Meterset Weight	300A,010E	DS	
>Number of Control Points	300A,0110	IS	
>Control Point Sequence	300A,0111	SQ	
>>Control Point Index	300A,0112	IS	
>>Cumulative Meterset Weight	300A,0134	DS	
>>Referenced Dose Reference Sequence	300C,0050	SQ	
>>>Referenced Dose Reference Number	300C,0051	IS	Only used by automatic isocenter PTV assignment to find related target volume for this beam.
>>>Cumulative Dose Reference Coefficient	300A,010C	DS	
>>Nominal Beam Energy	300A,0114	DS	
>>Dose Rate Set	300A,0115	DS	
>>Beam Limiting Device Position Sequence	300A,011A	SQ	
>>>RT Beam Limiting Device Type	300A,00B8	CS	
>>>Leaf/Jaw Positions	300A,011C	DS	
>>Gantry Angle	300A,011E	DS	
>>Gantry Rotation Direction	300A,011F	CS	
>>Beam Limiting Device Angle	300A,0120	DS	
>>Beam Limiting Device Rotation Direction	300A,0121	CS	

Attribute Name	Tag	VR	Import
>>Patient Support Angle	300A,0122	DS	
>>Patient Support Rotation Direction	300A,0123	CS	
>>Table Top Eccentric Angle	300A,0125	DS	
>>Table Top Eccentric Rotation Direction	300A,0126	CS	
>>Table Top Pitch Angle	300A,0140	DS	
>>Table Top Pitch Rotation Direction	300A,0142	CS	
>>Table Top Roll Angle	300A,0144	DS	
>>Table Top Roll Rotation Direction	300A,0146	CS	
>>Table Top Vertical Position	300A,0128	DS	
>>Table Top Longitudinal Position	300A,0129	DS	
>>Table Top Lateral Position	300A,012A	DS	
>>Isocenter Position	300A,012C	DS	Used for positioning

Table 8-28: RT Beams Module

8.1.2.3 Exported Modules

8.1.2.3.1 RT Image Module

Attribute Name	Tag	VR	Export
Samples per Pixel	0028,0002	US	"1"
Photometric Interpretation	0028,0004	CS	"MONOCHROME2"
Bits Allocated	0028,0100	US	"8"
Bits Stored	0028,0101	US	"8"
High Bit	0028,0102	US	"7"
Pixel Representation	0028,0103	US	"0"
RT Image Label	3002,0002	SH	(see Note 8-2)
RT Image Name	3002,0003	LO	(see Note 8-2)
RT Image Description	3002,0004	ST	(see Note 8-2)
Operators' Name	0008,1070	PN	
Image Type	0008,0008	CS	(see Note 8-3)
Conversion Type	0008,0064	CS	"DI" or "WSD"
Reported Values Origin	3002,000A	CS	"PLAN" or "ACTUAL"
RT Image Plane	3002,000C	CS	Always "NORMAL" to beam axis
X-Ray Image Receptor Translation	3002,000D	DS	(see Note 8-4)
X-Ray Image Receptor Angle	3002,000E	DS	"0"
RT Image Orientation	3002,0010	DS	Normal to beam axis, thus "1,0,0,0,-1,0"
Image Plane Pixel Spacing	3002,0011	DS	According to the flat panel manufacturer's specification.
RT Image Position	3002,0012	DS	(-columns * PixelSpacingX / 2.0, rows * PixelSpacingY / 2.0)
Radiation Machine Name	3002,0020	SH	Configurable: "ExacTrac Xray" or the Treatment Machine Name from RT Plan.
Exposure Sequence	3002,0030	SQ	Only if 3rd parameter of Image Type is "RADIOGRAPH" or "PORTAL".
>KVP	0018,0060	DS	
>Exposure Time	0018,1150	IS	
>X-ray Tube Current	0018,1151	IS	
>Meterset Exposure	3002,0032	DS	Only if 3rd parameter of Image Type is "PORTAL".
>Number of Blocks	300a,00F0	IS	0
Primary Dosimeter Unit	300A,00B3	CS	
Radiation Machine SAD	3002,0022	DS	(see Note 8-5)
RT Image SID	3002,0026	DS	(see Note 8-6)
Referenced RT Plan Sequence	300C,0002	SQ	
>Referenced SOP Class UID	0008,1150	UI	
>Referenced SOP Instance UID	0008,1155	UI	(see Note 8-7)
Referenced Beam Number	300C,0006	IS	(see Note 8-7)
Referenced Fraction Group Number	300C,0022	IS	
Gantry Angle	300A,011E	DS	(see Note 8-8)
Gantry Pitch Angle	300A,014A	DS	(see Note 8-8)
Beam Limiting Device Angle	300A,0120	DS	
Patient Support Angle	300A,0122	DS	The planned Patient Support Angle. In case of Image Type ...DRRTREATMENT_POS: the vertical angle of the fusion result is added (in degrees).
Table Top Vertical Position	300A,0128	DS	

Attribute Name	Tag	VR	Export
Table Top Longitudinal Position	300A,0129	DS	
Table Top Lateral Position	300A,012A	DS	
Table Top Pitch Angle	300A,0140	FL	The planned Table Top Pitch Angle. In case of Image Type ...\\DRR\\TREATMENT_POS: this angle is set to the lateral angle of the fusion result (in degrees).
Table Top Roll Angle	300A,0144	FL	The planned Table Top Roll Angle. In case of Image Type ...\\DRR\\TREATMENT_POS: this angle is set to the longitudinal angle of the fusion result in degrees.
Isocenter Position	300A,012C	DS	The isocenter position from the related DICOM RT Plan. In case of Image Type ...\\DRR\\TREATMENT_POS: the translation is applied to the Isocenter Position taking into account the Patient Position from the referenced RT Plan (supported so far: HFP, FFP, HFS, FFS).
Patient Position	0018,5100	CS	

Table 8-29: RT Image Module

Note 8-2: The content of RT Image Label, RT Image Name and RT Image Description can be configured and adapted to the needs of the local environment. See the ExacTrac manual for details.

Note 8-3: Image Type (0008,0008) contains one of the following parameters:

X-rays	ORIGINAL\\PRIMARY\\RADIOGRAPH or ORIGINAL\\PRIMARY\\PORTAL	The x-ray images acquired during the correction procedure. Note: The third parameter can be configured to be "PORTAL" for systems that cannot handle the value "RADIOGRAPH"
DRRs	DERIVED\\SECONDARY\\DRR	The initial DRRs at the planned treatment position.
	DERIVED\\SECONDARY\\DRR\\TREATMENT_POSITION	The DRRs in the actual treatment position, corresponding to the x-ray images, including the correction result.

Note 8-4: The Image Receptor is expected to be at the same position as an EPID (Gantry Angle = 0, Gantry Pitch Angle = 0).

Thus, the X-ray Image Receptor Translation calculates like: $((\text{Columns} / 2 - \text{PPX}) * \text{PixelSpacingX}, -(\text{Rows} / 2 - \text{PPY}) * \text{PixelSpacingY}, \text{SAD} - \text{SID})$, where PPX, and PPY are the coordinates of the principal point.

Note 8-5: Using the ExacTrac Camera Projection Matrix P, the center of the camera is computed. The distance between this point and the isocenter (0,0,0) yields SAD.

Note 8-6: The distance between the isocenter and a second point – also located in the isocenter plane – is computed in 3D. These two points are now projected in the plane, and again the distance in mm is computed using the known Pixel Spacing of the Flat Panel. Multiplying the ratio of the distance in the plane and the distance in space with SAD, yields SID.

Note 8-7: Referenced RT Plan and Referenced Beam Number are taken from the imported plan. If the imported plan has a Referenced RT Plan Sequence Item with the RT Plan Relationship EQUIVALENT, this SOP Instance UID is used instead.

Note 8-8: Gantry Angle and Gantry Pitch Angle are used to define the viewing angles of the ExacTrac imaging system. The two angles are determined by computing the x- (pitch) and y- (roll) angles where the viewing axes intersect the z-axis of the IEC Fixed Reference Coordinate System.

8.1.2.3.2 Spatial Registration

Attribute Name	Tag	VR	XRay Correction Export	CBCT Correction Export
Content Date	0008,0023	DA		
Content Time	0008,0033	TM		
Instance Number	0020,0013	IS		
Content Label	0070,0080	CS	"EXACTRAC_REG"	"EXACTRAC_REG"
Content Description	0070,0081	LO	"Registration of Planning FOR to Treatment FOR"	Related RTPLAN SOP Instance UID
Content Creator's Name	0070,0086	PN		
Registration Sequence	0070,0308	SQ	Contains exactly 2 sequence items	Contains exactly 2 sequence items
>Frame of Reference UID	0020,0052	UI		
>Referenced Image Sequence	0008,1140	SQ	Not used	Related CT or CBCT instances
>>Include 'Image SOP Instance Reference Macro' Table 10-3				
>Matrix Registration Sequence	0070,0309	SQ		
>>Frame of Reference Transformation Comment	3006,00C8	LO	(See Note 8-9)	(See Note 8-9)
>>Registration Type Code Sequence	0070,030D	SQ		
>>>Include 'Code Sequence Macro' Table 8.8-1				
>>Matrix Sequence	0070,030A	SQ		
>>>Frame of Reference Transformation Matrix	3006,00C6	DS	(See Note 8-10)	(See Note 8-11)
>>>Frame of Reference Transformation Matrix Type	0070,030C	CS	"RIGID"	"RIGID"
>Used Fiducials Sequence	0070,0314	SQ	Not used	Not used
>>Include 'SOP Instance Reference Macro' Table 10-11				
>>Fiducial UID	0070,031A	UI		

Table 8-30: Spatial Registration Module

Note 8-9: The Frame of Reference Transformation Comment (3006,00C8) is "IDENTITY", if the Frame of Reference in this Registration Sequence item is identical to the Frame of Reference of the Spatial Registration SOP Instance. The value is "SOURCE", if the matrix describes the actual transformation between the reference data FOR and the acquisition data FOR.

Note 8-10: The Registration Sequence (0070,0308) always contains 2 entries that describe the transformation of the reference and treatment data Frame of References (FOR) to the common FOR defined in the Spatial Registration object instance. For Xray correction export, both entries contain the unity matrix. The Spatial Registration does not include the shift result of the correction procedure. This result is encoded in the corresponding RT Image data.

Note 8-11: The Registration Sequence (0070,0308) always contains 2 entries that describe the transformation of the reference and treatment data Frame of References (FOR) to the common FOR defined in

the Spatial Registration object instance. For CBCT correction export, the planning CT FOR is used as the common FOR. Therefore, the Frame of Reference Transformation Matrix describing the transformation of the planning data (CT) to the common FOR contains the unity matrix. The second matrix describes the transformation of the treatment data (CBCT) FOR to the common FOR.

8.1.2.3.3 Common Instance Reference

Attribute Name	Tag	VR	Export
Referenced Series Sequence	0008,1115	SQ	All instances referencing the Frames of Reference within the Registration Sequence (0070,0308)
>Series Instance UID	0020,000E	UI	
>Referenced Instance Sequence	0008,114A	SQ	
>>Include 'SOP Instance Reference Macro' Table 10-11			

Table 8-31: Common Instance Reference Module

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 and 0099. Further details on usage of these private attributes are contained in Section 8.1.

8.2.1 Group 300B

Tag	Attribute Name	VR	VM
(300B,00xx)	Private Creator Code 'Brainlab - ONC - Beam Parameters'	LO	1
(300B,xx10)	Referenced Beam List	IS	1

Table 8-32: Beam Parameters

8.2.2 Group 3275

Tag	Attribute Name	VR	VM
(3275,00xx)	Private Creator Code 'Varian Medical Systems VISION 3275'	LO	1
(3275,xx00)	Registration Sub Type	LO	1

Table 8-33: Varian Registration Sub Type

8.3 Coded Terminology and Templates

CID 4051 General Devices

Context ID 4051

General Devices

Type: Extensible

Version: 20061023

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
INCLUDE CID BL-GEN-00001		

CID BL-GEN-00001

Brainlab Device Definitions

Context ID BL-GEN-00001

Localizer Definitions

Type: Extensible **Version:** 20100812

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
BL-GEN-LOC	LOC-HEADRING	Headring
BL-GEN-LOC	LOC-LOCALIZER	Localizer

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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