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Digital Imaging and Communications in Medicine (DICOM)

Supplement 134: Implantation Plan SR Document

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Prepared by:

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Scope and Field of Application

The aim of this Supplement is to communicate Implantation Planning information from the planning workstation to the operating room (OR). A prerequisite is that the DICOM Implant Templates are used for the Implantation Planning. This supplement introduces the Implantation
65   Plan SR Document.

An Implantation Plan SR Document Instance is the result of a planning process wherein specific implant templates are selected and positioned according to the images and other data of a patient. However, the Implantation Plan SR Document IOD does not describe the implantation process itself.

70   The supplement is based on the DICOM concept of Structured Reports (SR). The Implantation Plan SR Document allows use by machines in the OR (e.g. navigation systems) and includes information that can be displayed to the surgeon. Beside the communication of planning results, this Implantation Plan SR Document can also be used for documentation.

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85 **Changes to NEMA Standards Publication PS 3.2-2009**

Digital Imaging and Communications in Medicine (DICOM)

Part 2: Conformance

Item: Add SOP Class to Table A.1-2

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Table A.1-2
UID VALUES

UID Value	UID NAME	Category
…		
1.2.840.10008.5.1.4.1.1.88.70	**Implantation Plan SR Document Storage**	**Transfer**
…		

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Changes to NEMA Standards Publication PS 3.3-2009

Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

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Item: Add in Section A.1.4, rows and column to Table A.1-1

A.1.4 Overview of the Composite IOD Module Content

110

Modules / IODs	Implantation Plan SR Document
Patient	**M**
Clinical Trial Subject	**U**
General Study	**M**
Patient Study	**U**
Clinical Trial Study	**U**
Clinical Trial Series	**U**
SR Document Series	**M**
General Equipment	**M**
Enhanced General Equipment	**M**
SR Document General	**M**
SR Document Content	**M**
SOP Common	**M**

Item: Add in the following new section in Annex A

A.35 STRUCTURED REPORT DOCUMENT INFORMATION OBJECT DEFINITIONS

A.35.Y IMPLantation Plan SR Document information object definition

115 **A.35.Y.1 Implantation Plan SR Document IOD Description**

The Implantation Plan SR Document IOD contains the results of a planning process for an individual patient, wherein specific implant templates are selected and positioned using images of the patient. The Implantation Plan SR Document references the implant templates, the images, and the registration SOP instances that are used in the planning.

120 **A.35.Y.2 Implantation Plan SR Document IOD Entity-Relationship Model**

The E-R Model in Section A.1.2 of this Part applies to the Implantation Plan SR Document. The Frame of Reference IE, and the IEs at the level of the Image IE in Section A.1.2 are not components of the Implantation Plan SR Document IOD. Table A.35.Y-1 specifies the Modules of the Implantation Plan SR Document IOD.

125 **A.35.Y.3 Implantation Plan SR Document IOD Module Table**

Table A.35.Y-1
IMPLANTATION PLAN SR DOCUMENT IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.Y.3.1   IMPLANTATION PLAN SR DOCUMENT IOD Content Constraints

130   **A.35.Y.3.1.1   Template Constraints**

The document shall be constructed from TID 7000 Implantation Plan SR Document Root invoked at the root node.

   Note: All Template and Context Group definitions are located in PS 3.16, DICOM Content Mapping Resource, in the Annexes titled DCMR Templates and DCMR Context Groups, respectively.

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A.35.Y.3.1.2   Value Type

Value Type (0040,A040) in the Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

140   TEXT
            CODE
            NUM
            UIDREF
            COMPOSITE
145   IMAGE
            CONTAINER
            DATE
            PNAME

150   **A.35.Y.3.1.3   Relationship Constraints**

Relationships between content items in the content of this IOD may be conveyed by-value. Table A.35.Y-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.Y-2
155   **RELATIONSHIP CONTENT CONSTRAINTS FOR IMPLANTATION PLAN SR DOCUMENT IOD**

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, UIDREF, COMPOSITE[1], IMAGE[1], CONTAINER
CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATE, UIDREF, PNAME, COMPOSITE[1]
any type	HAS CONCEPT MOD	TEXT, CODE[2]
TEXT, CODE, NUM,	HAS PROPERTIES	TEXT, CODE, NUM, UIDREF, IMAGE[1],

IMAGE, UIDREF, COMPOSITE		COMPOSITE[1]

Notes: 1. Which SOP Classes the IMAGE or COMPOSITE Value Type may refer to is documented in the Conformance Statement for an application (see PS 3.2 and PS 3.4).

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2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example, to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

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Changes to NEMA Standards Publication PS 3.4-2009

Digital Imaging and Communications in Medicine (DICOM)

175   **Part 4: Service Class Specifications**

Item: Add the following to Table B.5-1

B.5 STANDARD SOP CLASSES

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**Table B.5-1
STANDARD SOP CLASSES**

SOP Class Name	SOP Class UID	IOD Specification (defined in PS 3.3)
Implantation Plan SR Document Storage	**1.2.840.10008.5.1.4.1.1.88.70**	Implantation Plan SR Document

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Item: Add the following to Section B.5.1.5
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185 **B.5.1.5 Structured Reporting Storage SOP Classes**

The requirements of Annex O apply to the following SOP Classes:

…

- **Implantation Plan SR Document**

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190 **Item: Add the following to Table I.4-1**

I.4 MEDIA STORAGE STANDARD SOP CLASSES

**Table I.4-1
Media Storage Standard SOP Classes**

SOP Class Name	SOP Class UID	IOD Specification
Implantation Plan SR Document Storage	**1.2.840.10008.5.1.4.1.1.88.70**	Implantation Plan SR Document

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Item: Add the following to Section I.4.1.2

I.4.1.2 Structured Reporting Storage SOP Classes

The requirements of Annex O apply to the following SOP Classes:

200 …

- **Implantation Plan SR Document**

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Changes to NEMA Standards Publication PS 3.6-2009

Digital Imaging and Communications in Medicine (DICOM)

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Part 6: Data Dictionary

Item: Add the following UID to Part 6 Annex A:

Annex A   Registry of DICOM unique identifiers (UID)
220
(Normative)

Table A-1
UID VALUES

UID Value	UID NAME	UID TYPE	Part
…			
1.2.840.10008.5.1.4.1.1.88.70	**Implantation Plan SR Document Storage**	**SOP Class**	**PS 3.4**
…			

Add and correct the following UIDs to Part 6 Annex A Table A-3:

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Table A-3
CONTEXT GROUP UID VALUES

Context UID	Context Identifier	Context Group Name
…		
1.2.840.10008.6.1.924	**7320**	**Planning Methods**
…		

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235 **Changes to NEMA Standards Publication PS 3.16-2009**

Digital Imaging and Communications in Medicine (DICOM)

Part 16: DICOM Content Mapping Resource

Add the following to Part 16 Section 2

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240 **Implants**

[Eggli et. al.1998]   S. Eggli, M. Pisan, and M. E. Müller, "The value of preoperative planning for total hip arthroplasty," *J Bone Joint Surg Br* 80-B, Nr. 3 (May 1, 1998): 382-390.

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245 **Add the following Templates to Part 16 Annex A Structured Reporting Templates (Normative)**

IMPLANTATION PLAN SR DOCUMENT TEMPLATES

The templates that comprise the Implantation Plan SR Document IOD are interconnected as in
250 Figure A-X.
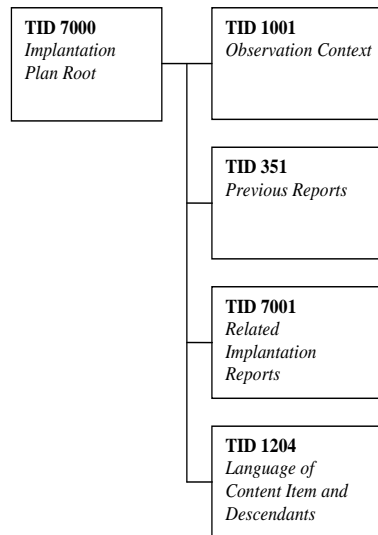
Figure A-X: Implantation Plan SR Document IOD Template Structure TID 7000 Implantation Plan Template

255 This template contains all the necessary information to position an Implant Assembly and its Components in a patient. Therefore, all the Components that comprise an Implant Assembly are listed. If the Implant Assembly consists of more than one Component, the relation between the Components will be described as well. It is also possible to describe the registration between the Components and the patient and between the Components themselves.

260 To reference the Components within this document the Implantation Plan Component ID is used.

The Component Connection links two Implantation Plan Components in a commutative way. This means that for each link between A and B only one Component Connection has to be defined and not two for A-B and B-A.

The terminology used is defined by illustration using the example in figure A-Z.
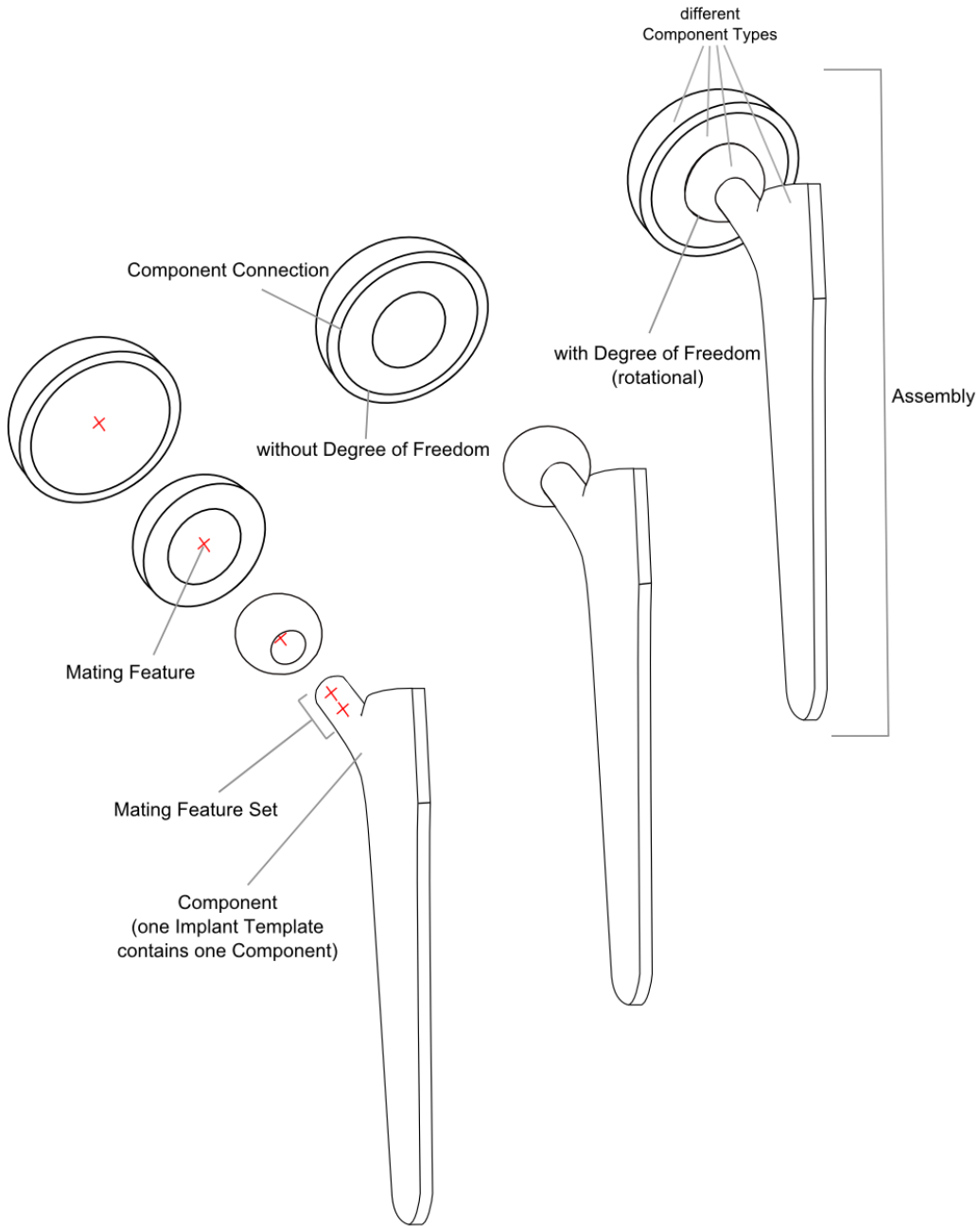
265

Figure A-Z: Figure to illustrate the used terminology

TID 7000
IMPLANTATION PLAN
Type: Extensible

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint

1			CONTAINER	EV (112345, DCM, "Implantation Plan")	1	M		
2	>	HAS CONCEPT MOD	INCLUDE	DTID (1204) Language of Content Item and Descendants	1	U		
3	>	HAS OBS CONTEXT	INCLUDE	DTID (1001) Observation Context	1	M		
4	>	CONTAINS	INCLUDE	DTID (351) Previous Reports	1	MC	IFF previous Implantation Plan Documents exist	Shall only reference other Implantation Plan Documents
5	>	CONTAINS	INCLUDE	DTID (7001) Related Implantation Reports	1	MC	IFF related Implantation Plan Documents exist that are not referenced by row 4	Shall only reference other Implantation Plan Documents
6	>	CONTAINS	CONTAINER	EV (112360, DCM, "Implant Component List")	1	M		
7	>>	CONTAINS	COMPOSITE	EV (112366, DCM, "Implant Assembly Template")	1	U		References an Implant Assembly Template SOP Instance
8	>>	CONTAINS	CONTAINER	EV (112346, DCM, "Selected Implant Component")	1-n	M		
9	>>>	CONTAINS	TEXT	EV (112347, DCM, "Component ID")	1	M		
10	>>>	CONTAINS	CODE	EV (112370, DCM, "Component Type")	1	MC	IFF Row 8 contains more than one item.	DCID (7306), Implants Component Type (Sup. 131)
11	>>>	CONTAINS	COMPOSITE	No purpose of reference	1	M		References an Implant Template Storage SOP Instance
12	>>>	CONTAINS	UIDREF	EV (112227, DCM, "Frame Of Reference UID")	1	M		
13	>>>	CONTAINS	COMPOSITE	EV (112371, DCM, "Manufacturer Implant Template")	1	M		References an Implant Template Storage SOP Instance
14	>	CONTAINS	CONTAINER	EV (112355, DCM, "Assembly")	1-n	U		
15	>>	CONTAINS	CONTAINER	EV (112350, DCM, "Component Connection")	1-n	M		
16	>>>	CONTAINS	CONTAINER	EV (112374, DCM, "Connected Implantation Plan Component")	2	M		
17	>>>>	CONTAINS	TEXT	EV (112347, DCM, "Component ID")	1	M		Defined in the Implant Component List CONTAINER
18	>>>>	CONTAINS	TEXT	EV (112351, DCM, "Mating Feature Set ID")	1	M		Only one Component Connection per Mating Feature Set is allowed
19	>>>>	CONTAINS	TEXT	EV (112352, DCM, "Mating Feature ID")	1	M		
20	>>>>	CONTAINS	CONTAINER	EV (112362, DCM, "Degrees of Freedom Specification")	1-n	U		

21	>>>>>	CONTAINS	TEXT	EV (112363,DCM, "Degree of Freedom ID")	1	M		
22	>>>>>	CONTAINS	NUM	EV (112376,DCM, "Degree of Freedom Exact Translational Value")	1	MC	IFF Row 23, 24, 25, 26 and 27 are absent	UNITS=EV (mm, UCUM, "mm")
23	>>>>>	CONTAINS	NUM	EV (112377,DCM, "Degree of Freedom Minimum Translational Value")	1	MC	IFF row 22, 25, 26, and 27 are absent	UNITS=EV (mm, UCUM, "mm")
24	>>>>>	CONTAINS	NUM	EV (112378,DCM, "Degree of Freedom Maximum Translational Value")	1	MC	IFF row 22, 25, 26, and 27 are absent	UNITS=EV (mm, UCUM, "mm")
25	>>>>>	CONTAINS	NUM	EV (112379,DCM, "Degree of Freedom Exact Rotational Value")	1	MC	IFF row 22, 23, 24, 26 and 27 are absent	UNITS=EV (deg, UCUM, "degree")
26	>>>>>	CONTAINS	NUM	EV (112380,DCM, "Degree of Freedom Minimum Rotational Value")	1	MC	IFF row 22, 23, 24 and 25 are absent	UNITS=EV (deg, UCUM, "degree")
27	>>>>>	CONTAINS	NUM	EV (112381,DCM, "Degree of Freedom Maximum Rotational Value")	1	MC	IFF row 22, 23, 24 and 25 are absent	UNITS=EV (deg, UCUM, "degree")
28	>	CONTAINS	CONTAINER	EV (112358, DCM, "Information used for planning")	1	U		
29	>>	CONTAINS	CODE	EV (112375, DCM, "Planning Method")	1	U		BCID (7320) Planning Methods
30	>>	CONTAINS	IMAGE	EV (112354, DCM, "Patient Image")	1-n	U		
31	>>>	HAS PROPERTIES	NUM	EV (111026, DCM, "Horizontal Pixel Spacing")	1	M		UNITS = EV (mm/{pixel}, UCUM, "mm/pixel")
32	>>>	HAS PROPERTIES	NUM	EV (111026, DCM, "Vertical Pixel Spacing")	1	M		UNITS = EV (mm/{pixel}, UCUM, "mm/pixel")
33	>>	CONTAINS	COMPOSITE	EV (112361, DCM, "Patient Data Used During Planning")	1-n	U		References SOP Instances except Images
34	>>>	HAS PROPERTIES	UIDREF	EV (112356, DCM, "User Selected Fiducial")	1-n	MC	IFF row 33 references a Fiducial SOP Instance	
35	>>>>	HAS CONCEPT MOD	TEXT	EV (112369, DCM, "Fiducial Intent")	1	U		
36	>	CONTAINS	CONTAINER	EV (112367, DCM, "Planning Information for Intraoperative Usage")	1	U		
37	>>	CONTAINS	TEXT	EV (121173, DCM, "Physician Note")	1-n	U		
38	>>	CONTAINS	COMPOSITE	EV (112359, DCM, "Supporting Information")	1	U		SOP Class UID shall be Encapsulated PDF Storage

39	>>	CONTAINS	COMPOSITE	EV (112372, DCM, "Derived Planning Images")	1-n	U		
40	>>	CONTAINS	COMPOSITE	EV (112353, DCM, "Spatial Registration")	1-n	U		References Spatial Registration SOP Instances and Deformable Spatial Registration SOP Instances
41	>>>	HAS PROPERTIES	UIDREF	EV (112227, DCM, "Frame of Reference UID")	1-n	U		
42	>>	CONTAINS	COMPOSITE	EV (112373, DCM, "Derived Planning Data")	1-n	U		References SOP Instances except Images and Spatial Registrations
43	>>>	HAS PROPERTIES	UIDREF	EV (112357, DCM, "Derived Fiducial")	1-n	MC	IFF row 42 references a Fiducial SOP Instance	
44	>>>>	HAS CONCEPT MOD	TEXT	EV (112369, DCM, "Fiducial Intent")	1	U		
45	>>	CONTAINS	COMPOSITE	EV (112364, DCM, "Related Patient Data Not Used During Planning")	1-n	U		

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Content Item Descriptions

Row 7	If an Implant Assembly Template was used for the planning, it should be referenced here.
Row 9	ID given to this Implant Component. Used to reference this specific Component within the Implantation Plan.
Row 10	See description of Component Type Code Sequence (0076,0034) Attribute in Template Assembly Module in PS 3.3
Row 11	Reference to the Template that describes that component. May be the same Implant Template as referenced in row 13. The target of the reference may not be needed or available during implantation. e.g. if the plan is opened in another hospital where those implant templates are not used.
Row 12	This Frame of Reference is the Frame of Reference of the Implant Component (Frame of Reference UID (0020,0052) Attribute in the Generic Implant Template Module in PS 3.3). This may help to find the right registration information (row 43).
Row 13	References the Original Template which was the basis for the Derived Template. May be the same Implant Template as referenced in row 11. The target of the reference may not be needed or available during implantation. e.g. if the plan is opened in another hospital where those implant templates are not used.
Row 14	If there is no Component Connection between sets of Implant Components, one Assembly must be used for each set.
Row 17	The ID of a planned Component that is defined in this document and which is part of this Relation.
Row 18	See description of Mating Feature Set ID (0068,63C0) Attribute in the Generic Implant Template Module in PS 3.3
Row 19	See description of Mating Feature ID (0068,63F0) Attribute in the Generic Implant Template Module in PS 3.3
Row 21	See description of Degree of Freedom ID (0068,6410) Attribute in the Generic Implant Template Module in PS 3.3

Row 22 – 27	Defines the range or exact value that was selected or calculated by the planning application.
Row 31	Defines the calibrated Horizontal Pixel Spacing that was used by the planning application, which may be different from the spacing encoded in the referenced Image SOP Instance.
Row 32	Defines the calibrated Vertical Pixel Spacing that was used by the planning application, which may be different from the spacing encoded in the referenced Image SOP Instance.
Row 33	Any patient data other than Image IEs used for the planning, e.g., Surface Segmentations.
Row 34	Fiducials selected by the user for registration of implant components referenced in the parent content item.
Row 35	User comment about the Fiducial. This may be the reason it was selected, the intended use, the anatomical or non-anatomical structure that the Fiducial represents, or any other intent.
Row 38	All kinds of information in PDF form that are created by a planning application may be referenced here, e.g., drawings.
Row 39	All kinds of images that are created by a planning application should be referenced here, e.g. images that show patient images overlaid with contour information of the Implant Component, or images that show how several implant components may be composed, or merged patient images.
Row 40	References registration objects that contain registration data that is relevant for this Implantation Plan, e.g., registration of Implant Components.
Row 41	Identifies one or more items within the sequence of referenced Frames of Reference (Registration Sequence (0070,0308) in the Spatial Registration Module or Deformable Registration Sequence (0064,0002) in the Deformable Spatial Registration Module in PS 3.3) that are relevant for this Implantation Plan. See Figure A-Y.
Row 42	Any patient data created during the planning process that is not referenced in row 39 and 40, e.g., Surface Segmentation Instances created by the planning application.
Row 43	These Fiducials are derived from the Fiducials identified in Row 34.
Row 45	References to any relevant patient data containing IOD instances that were not used in planning or derived from it but belong to the patient model. Might be reports, images, surface segmentations, or other.
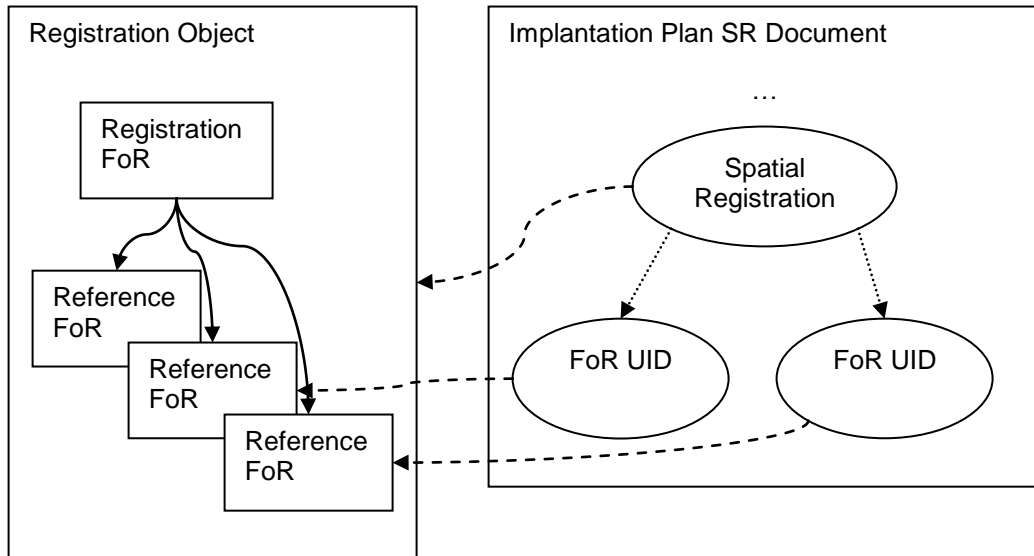
Figure A-Y: References to Registration Objects

TID 7001 Related Implantation Reports

275 This general template provides a means to reference related Implantation Plan SR Document
instances that are not previous Reports. Other Implantations that are planned to be done during
the same intervention should be referenced here.

TID 7001
RELATED IMPLANTATION REPORTS
280 **Type: Extensible**

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (112365, DCM, "Related Implantation Reports")	1	M		
2	>	CONTAINS	COMPOSITE		1-n	M		

Item: Add to Annex B DCMR Context Groups (Normative)

285 **CID 7320 Planning Methods**

Context ID 7320
Planning Methods
Type : Extensible   **Version: 20101102**

Code Scheme	Code Value	Concept Name

DCM	112340	Generic 2D Planning
DCM	112341	Generic 3D Planning
DCM	112342	Generic Planning for Hip Replacement
DCM	112343	Generic Planning for Knee Replacement
DCM	112344	Müller Method Planning for Hip Replacement

290 **Add the following definitions to Part 16 Annex D DICOM Controlled Terminology Definitions (Normative): Code value assignments will be resolved in the Final Text.**

Annex D   DICOM Controlled Terminology Definitions (Normative)

This Annex specifies the meanings of codes defined in DICOM, either explicitly or by reference to another part of DICOM or an external reference document or standard.

295   **DICOM Code Definitions (Coding Scheme Designator "DCM" Coding Scheme Version "01")**

Code Value	Code Meaning	Definition
112345	Implantation Plan	A Report containing the results of an Implantation Planning Activity
112346	Selected Implant Component	A selection of one Implant Component
112347	Component ID	Identification ID of an Implant Component
112348	Implant Template	An implant template describing the properties (2D/3D geometry and other data) of one Implant Component
112350	Component Connection	A connection of two Connected Implantation Plan Components
112351	Mating Feature Set ID	ID of a Mating Feature Set in an Implant Component
112352	Mating Feature ID	ID of the Mating Feature in a Mating Feature Set in an Implant Component
112353	Spatial Registration	The Spatial Registration of one or more Implant Components
112354	Patient Image	Patient Images used for an implantation planning activity
112355	Assembly	A collection of Component Connections of Implant Components
112356	User Selected Fiducial	Fiducials that are selected by the user and may or may not belong to anatomical landmarks
112357	Derived Fiducial	Fiducials that represent geometric characteristics, such as center of rotation, and are derived from other fiducials.

Code Value	Code Meaning	Definition
112358	Information used for planning	All parameters and data that were used for the planning activity
112359	Supporting Information	A description of the plan as encapsulated PDF SOP Instance
112360	Implant Component List	A list of all Implant Components selected for an implantation
112361	Patient Data Used During Planning	Reference to objects containing patient data that is used for planning
112362	Degrees of Freedom Specification	A specification of the values from one or more Degrees of Freedom
112363	Degree of Freedom ID	ID of one Degree of Freedom
112364	Related Patient Data Not Used During Planning	Reference to objects containing patient data that were not used for planning but are somehow related
112365	Related Implantation Reports	Implantation Reports that are somehow related e.g. contemporaneous implantations which are independent
112366	Implant Assembly Template	Implant Assembly Template
112367	Planning Information for Intraoperative Usage	Information that is intended to be used intraoperatively
112368	Implantation Patient Positioning	Position of the patient on the operating room table
112369	Fiducial Intent	Intended use of the fiducial
112370	Component Type	Type of an Implant Component
112371	Manufacturer Implant Template	Implant Template released by the Manufacturer
112372	Derived Planning Images	Images that are created by a planning application
112373	Other Derived Planning Data	Data that is created by a planning application
112374	Connected Implantation Plan Component	One Implant Component that is connected to another Implant Component
112375	Planning Method	The method used for planning
112376	Degree of Freedom Exact Translational Value	Defines the exact value that was planned for translation
112377	Degree of Freedom Minimum Translational Value	Defines the minimum value that was planned for translation
112378	Degree of Freedom Maximum Translational Value	Defines the maximum value that was planned for translation
112379	Degree of Freedom Exact Rotational Translation Value	Defines the exact value that was planned for rotation
112380	Degree of Freedom Minimum Rotational Value	Defines the minimum value that was planned for rotation
112381	Degree of Freedom Maximum Rotational Value	Defines the maximum value that was planned for rotation
112340	Generic 2D Planning	Planning by an unspecified 2D method

Code Value	Code Meaning	Definition
112341	Generic 3D Planning	Planning by an unspecified 3D method
112342	Generic Planning for Hip Replacement	Planning of a Hip Replacement, by an unspecified method
112343	Generic Planning for Knee Replacement	Planning of Knee Replacement, by an unspecified method
112344	Müller Method Planning for Hip Replacement	Planning of Hip Replacement according to the procedure of M. E. Müller [Eggli et. al.1998]

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Changes to NEMA Standards Publication PS 3.17-2009

Digital Imaging and Communications in Medicine (DICOM)

310

Part 17: Explanatory Information

<div style="border:1px solid black; padding:8px;">

Item: Add Annex X

</div>

ANNEX X: IMPLANTATION PLAN SR DOCUMENT (Informative)

315 For the implantation of bone mounted implants, information that has been generated during the implantation planning phase is needed in the OR. To convey this information to the OR, this supplement to the DICOM standard introduces the DICOM format for the results of an implantation planning activity referring to implant templates. An Implantation Plan SR Document should be utilized by surgeons, navigation devices, and for documentation purposes. The Plan

320 contains relevant intraoperative information concerning the assembly of the implant components, resection lines, registration information, and relevant patient data. Thus, the Implantation Plan SR Document can help to enhance information logistics within the workflow. It does not contain any information about the planned surgical workflow. This information may be addressed by other DICOM Supplements. Nevertheless, this SR document may reference to or may be referenced by

325 objects containing workflow information.
Additionally, once an implantation plan has been generated, it can be used as input for a planning application to facilitate adaption of a plan in cases where this is necessary due to unforeseen situations.

The workflow is considered to be the following:

330 Some kind of planning application helps the user to perform implantation planning; he can choose the optimal implant for a patient using implant templates from a repository. The user aligns the implant template with patient data with or without the help of the application. (Planning without patient data can be stored in the Implantation Plan SR Document as well.)
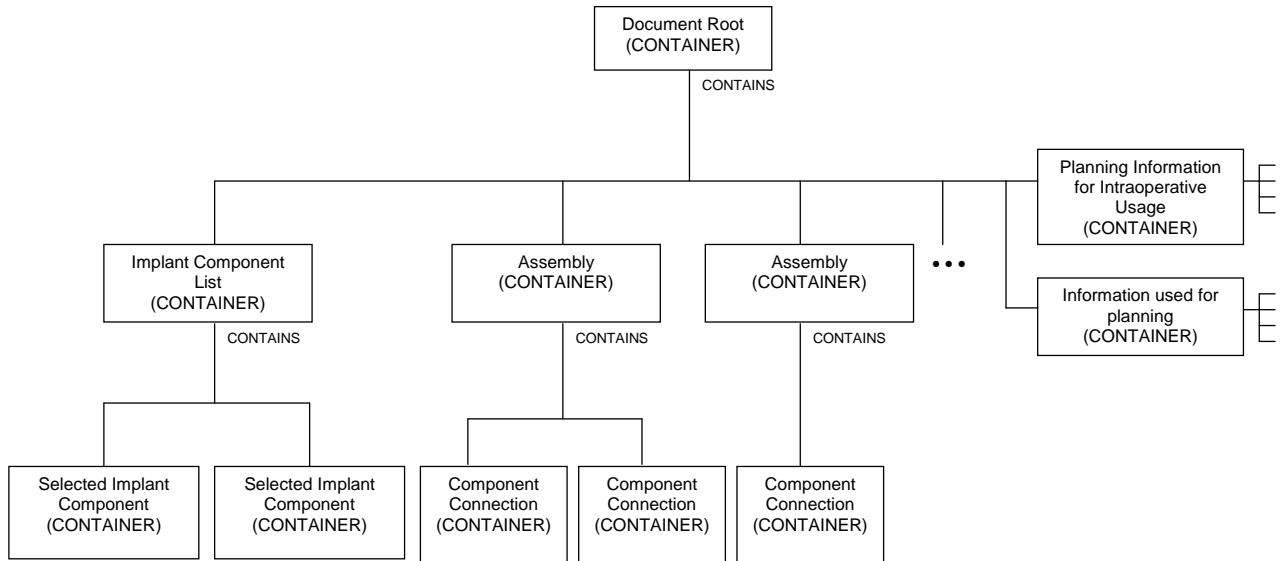
Subsequently, an Implantation Plan SR Document Instance will be created that contains the

335 results of the planning. No information of the process itself (previously chosen implant templates, methods, etc.) will be stored. However, an Implantation Plan Document is considered to contain the important parameters to retrace a planning result.

There are two main components an Implantation Plan SR Document consists of (see Figure X.1-1). The implant component selection is used to point to a selected implant template in the

340 repository, whereas the assembly is used to describe the composition of the selected implant templates. Figure X.2-1 shows how the Implantation Plan SR Document parts make references to the implant templates. Each Implantation Plan SR Document can contain a single implant component selection and several assemblies but it describes only one planning result for one particular patient.

345 The recipient of the Implantation Plan SR Document can decide whether to read only the "list" of used implants or to go into detail and read the compositions as well. In both cases, he must have access to the repository of the Implant Templates to get detailed information about the implant (such as its geometry).

X.1 IMPLANTATION PLAN SR DOCUMENT CONTENT TREE STRUCTURE

350 The following structure shows the main content of an Implantation Plan SR Document. As can be seen in Figure X.1-1, the Implantation Plan consists mainly of the selected Implant Components and their Assemblies.
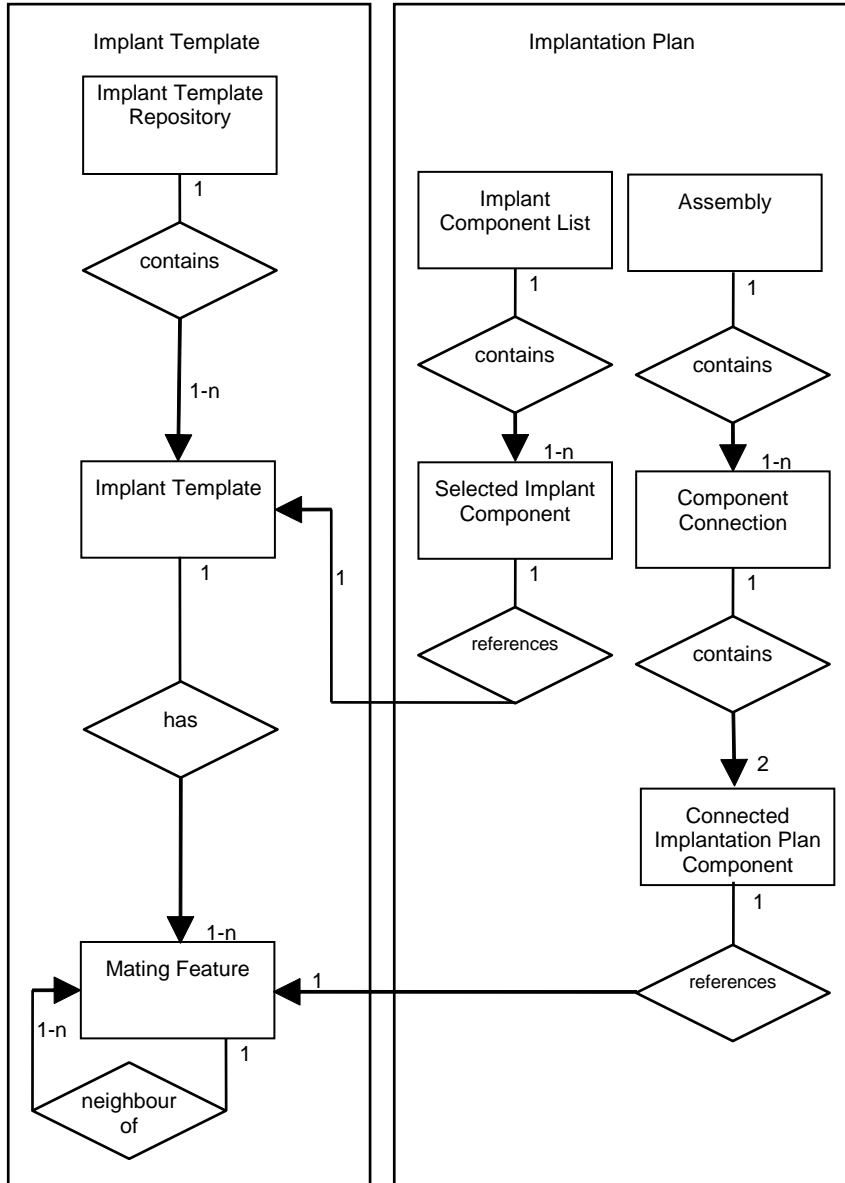
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Figure X.1-1: Implantation Plan SR Document basic content tree

X.2 RELATIONSHIP BETWEEN IMPLANT TEMPLATE AND IMPLANTATION PLAN

The Implantation Plan SR Document is tightly related to Implantation Templates (see PS 3.3 and PS 3.16). The following Figure X.2-1 shows the relationship between the Implant Templates and 360 the Implantation Plan.

Figure X.2-1: Implantation Plan SR Document and Implant Template Relationship Diagram

X.3 IMPLANTATION PLAN SR DOCUMENT TOTAL HIP REPLACEMENT EXAMPLE

The following example shows the planning result of a simple THR (Total Hip Replacement)
365   without any registration information. One Patient Image was used and one visualization was
produced. One Femoral Stem, one Femoral Head, one Acetabular Bearing Insert and one
Acetabular Fixation Cup were selected to be implanted (see Figure X.3-1).
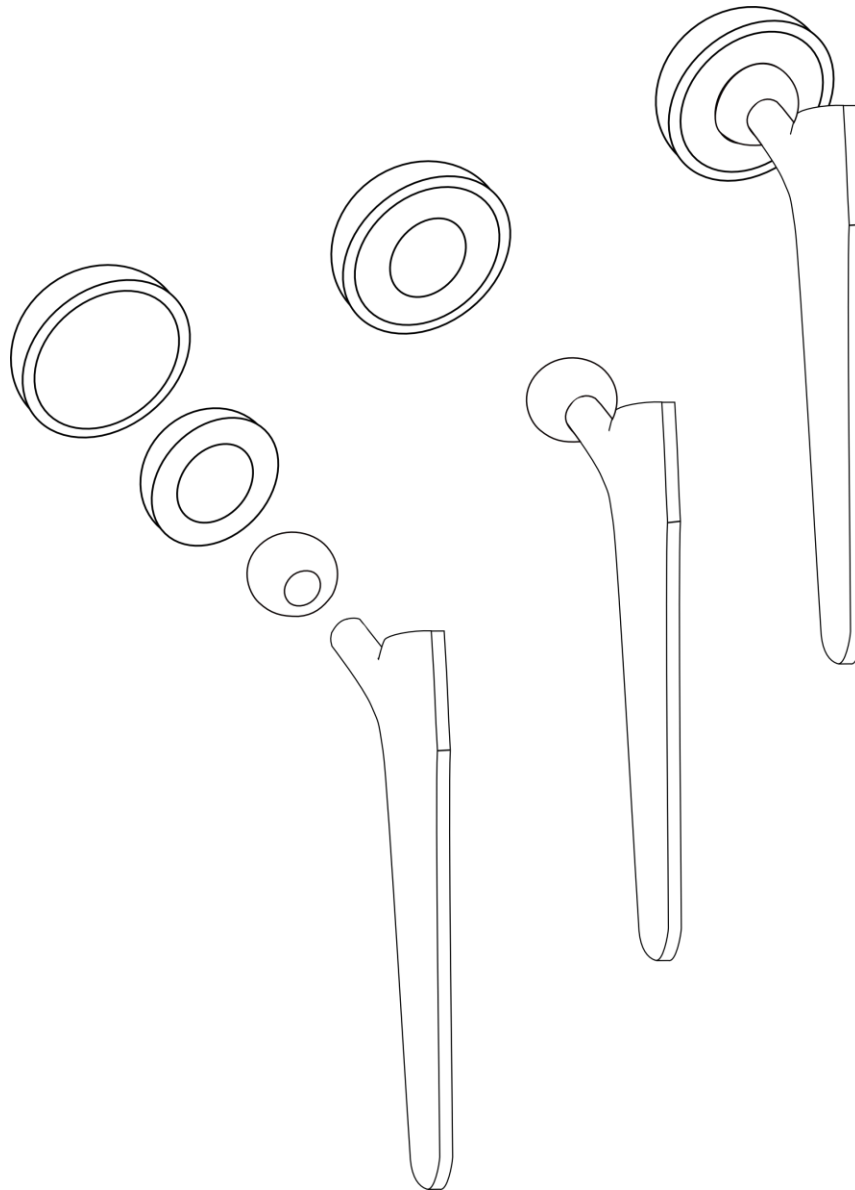
Figure X.3-1: Total Hip Replacement Components

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Table X.3-1
Total Hip Replacement Example

Node	Code Meaning of Concept Name	Code Meaning or Example Value	TID
1	Implantation Plan		7000
1.1	Language of Content Item and Descendants	English	1204
1.2	**Observation Context**		**1001**
1.2.1	Person Observer Name	Dr. Michael Mueller	1003
1.2.2	Subject Name	John Smith	1007
1.2.3	Subject ID	1.2.3.4.5.6.7.8.9	1007

Node	Code Meaning of Concept Name	Code Meaning or Example Value	TID
1.2.4	Subject Species	L-85B00, SRT,"homo sapiens"	1007
1.3	**Implant Component List**		**7000**
1.3.1	Implant Assembly Template	Reference to THR	7000
1.3.2	Selected Implant Component		7000
1.3.2.1	Component ID	1	7000
1.3.2.2	Component Type	112310	7000
1.3.2.3		Reference to Implant Template "FS1000" (derived)	7000
1.3.2.4	Frame Of Reference UID	1.2.3.4.1	7000
1.3.2.5	Manufacturer Implant Template	Reference to Implant Template "FS1000" (original)	7000
1.3.3	Selected Implant Component		7000
1.3.3.1	Component ID	2	7000
1.3.3.2	Component Type	A-04459	7000
1.3.3.3		Reference to Implant Template "FH2000" (derived)	7000
1.3.3.4	Frame Of Reference UID	1.2.3.4.2	7000
1.3.3.5	Manufacturer Implant Template	Reference to Implant Template "FH2000" (original)	7000
1.3.4	Selected Implant Component		7000
1.3.4.1	Component ID	3	7000
1.3.4.2	Component Type	112305	7000
1.3.4.3		Reference to Implant Template "AFC3000" (derived)	7000
1.3.4.4	Frame Of Reference UID	1.2.3.4.3	7000
1.3.4.5	Manufacturer Implant Template	Reference to Implant Template "AFC3000" (original)	7000
1.3.5	Selected Implant Component		7000
1.3.5.1	Component ID	4	7000
1.3.5.2	Component Type	112306	7000
1.3.5.3		Reference to Implant Template "ABI4000" (derived)	7000
1.3.5.4	Frame Of Reference UID	1.2.3.4.4	7000
1.3.5.5	Manufacturer Implant Template	Reference to Implant Template "ABI4000"	7000

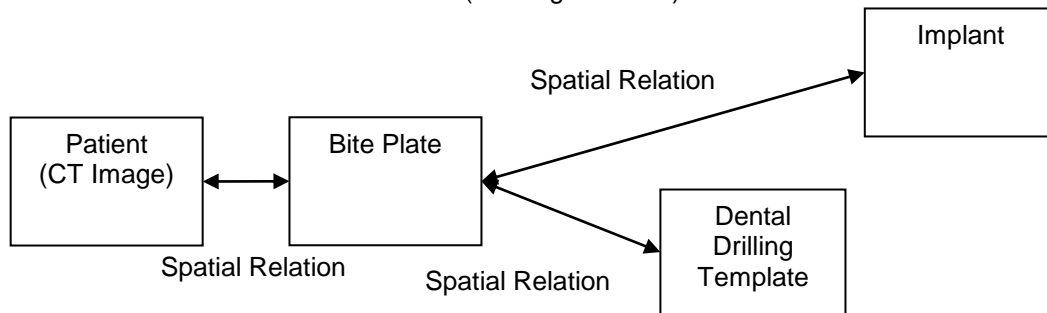| Node	Code Meaning of Concept Name	Code Meaning or Example Value	TID
		(original)	
1.4.	**Assembly**		**7000**
1.4.1	Component Connection		7000
1.4.1.1	Connected Implantation Plan Component		7000
1.4.1.1.1	Component ID	3	7000
1.4.1.1.2	Mating Feature Set ID	1	7000
1.4.1.1.3	Mating Feature ID	1	7000
1.4.1.2	Connected Implantation Plan Component		
1.4.1.2.1	Component ID	4	7000
1.4.1.2.2	Mating Feature Set ID	1	7000
1.4.1.2.3	Mating Feature ID	1	7000
1.4.2	Component Connection		7000
1.4.2.1	Connected Implantation Plan Component		7000
1.4.2.1.1	Component ID	2	7000
1.4.2.1.2	Mating Feature Set ID	1	7000
1.4.2.1.3	Mating Feature ID	1	7000
1.4.2.2	Connected Implantation Plan Component		7000
1.4.2.2.1	Component ID	1	7000
1.4.2.2.2	Mating Feature Set ID	1	7000
1.4.2.2.3	Mating Feature ID	2	7000
1.4.3	Component Connection		7000
1.4.3.1	Connected Implantation Plan Component		7000
1.4.3.1.1	Component ID	2	7000
1.4.3.1.2	Mating Feature Set ID	2	7000
1.4.3.1.3	Mating Feature ID	1	7000
1.4.3.2	Connected Implantation Plan Component		7000
1.4.3.2.1	Component ID	4	7000
1.4.3.2.2	Mating Feature Set ID	2	7000
1.4.3.2.3	Mating Feature ID	2	7000
1.5	**Information used for planning**		**7000**
1.5.1	Patient Image	Reference to Image 01	7000
1.5.1.2	Horizontal Pixel Spacing	0.2 mm/pixel	7000
1.5.1.3	Vertical Pixel Spacing	0.2 mm/pixel	7000
1.6	**Planning Information for Intraoperative Usage**		**7000**
1.6.1	Supporting Information	Reference to Encapsulated PDF-Document 01	7000
1.6.2	Derived Images	Reference to Visualization 01	7000

X.4 IMPLANTATION PLAN SR DOCUMENT DENTAL DRILLING TEMPLATE EXAMPLE

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The following example shows the result of a planning activity for a dental implantation using a dental drilling template. The implant positioning is based on a CT-Scan during which the patient has been wearing a bite plate with 3 markers. In this example the markers (visible in the patient's CT images) are detected by the planning application. After the implants have been positioned, the bite plate, in combination with the registration information of the implants, can be used to produce the dental drilling template.

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In the following example, two implants are inserted which are not assembled using Mating Points.

The markers of the bite plate are identified and stored as 3 Fiducials in one Fiducial Set. This Fiducial Set has its own Frame of Reference (1.2.3.4.100).

The Registration Object created by the planning application uses the patient's CT Frame of Reference as main Frame of Reference (See Figure F.4-1).

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Figure X.4-1: Spatial relations of Implant, Implant Template, Bite Plate and Patient CT

Table X.3-2
Dental Drilling Template Example

Node	Code Meaning of Concept Name	Code Meaning or Example Value	TID
1	Implantation Plan		7000
1.1	Language of Content Item and Descendants	English	1204
1.2	**Observation Context**		**1001**
1.2.1	Person Observer Name	Dr. Michael Mueller	1003
1.2.2	Subject Name	John Smith	1007
1.2.3	Subject ID	1.2.3.4.5.6.7.8.9	1007
1.2.4	Subject Species	L-85B00, SRT,"homo sapiens"	1007
1.3	**Implant Component List**		**7000**
1.3.1	Selected Implant Component		7000
1.3.1.1	Component ID	1	7000
1.3.1.2	Component Type	112305	7000

Node	Code Meaning of Concept Name	Code Meaning or Example Value	TID
1.3.1.3		Reference to Implant Template "DI1000" (derived)	7000
1.3.1.4	Frame Of Reference UID	1.2.3.4.1	7000
1.3.1.5	Manufacturer Implant Template	Reference to Implant Template "DI1000" (original)	7000
1.3.2	Implant Component Selection		7000
1.3.2.1	Component ID	2	7000
1.3.2.2	Component Type	112306	7000
1.3.2.3		Reference to Implant Template "DI2000" (derived)	7000
1.3.2.4	Frame Of Reference UID	1.2.3.4.2	7000
1.3.2.5	Manufacturer Implant Template	Reference to Implant Template "DI2000" (original)	7000
1.4	**Information used for planning**		**7000**
1.4.1	Patient Image	Reference to CT Image01	7000
1.4.1.2	Horizontal Pixel Spacing	0.3 mm/pixel	7000
1.4.1.3	Vertical Pixel Spacing	0.3 mm/pixel	
1.5	**Planning Information for Intraoperative Usage**		**7000**
1.5.1	Derived Planning Images	Reference to Visualization01	7000
1.5.2	Spatial Registration	Reference to Registration01	7000
1.5.2.1	Frame Of Reference UID	1.2.3.4.1	7000
1.5.2.2	Frame Of Reference UID	1.2.3.4.2	7000
1.5.2.3	Frame Of Reference UID	1.2.3.4.3	7000
1.5.2.4	Frame Of Reference UID	1.2.3.4.100	7000
1.5.3	Derived Planning Data	Reference to Fiducial 01	7000
1.5.3.1	Derived Fiducial	1.2.3.4.3	7000
1.5.3.1.1	Fiducial Intent	Bite Plate Marker	7000
1.5.3.2	Derived Fiducial	1.2.3.4.4	7000
1.5.3.2.1	Fiducial Intent	Bite Plate Marker	7000
1.5.3.3	Derived Fiducial	1.2.3.4.5	7000
1.5.3.3.1	Fiducial Intent	Bite Plate Marker	7000