Technical Publications

DOC2719402
Revision 3

Auto Segmentation Application on Edison HealthLink DICOM Conformance Statement

GE HealthCare

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REVISON HISTORY

REV.	DATE	REASON FOR CHANGE	Author
1	04-November-2022	Initial Release	Abhishek Dutta Gupta
2	21-September-2023	DLAS M2 changes Updated SeriesInstanceUID and SOPInstanceUID format in section 3.4.1 and 3.4.4	Vamshi Krishna
3	02-October-2023	Re-routing the document to add interoperability leader as one of the reviewers	Vamshi Krishna

CONFORMANCE STATEMENT OVERVIEW

Auto Segmentation is a post-processing application intended to assist clinician by generating contours of organ at risk (OAR) from a Computed Tomography (CT) image in the form of a DICOM Radiotherapy Structure Set (RTSS) series. It is designed to be used on Edison HealthLink (EHL), so networking and media storage features are inherited from this platform.

This DICOM Conformance Statement captures the DICOM capabilities of the GEHC Auto Segmentation Application on Edison HealthLink(EHL) identified below. This document applies to the following software release of the product:

Auto Segmentation 1.0 and higher

TABLE OF CONTENTS

1. INTRODUCTION

1.1 OVERVIEW

This DICOM Conformance Statement is divided into Sections as described below:

Section 1 (Introduction), which describes the overall structure, intent, and references for this Conformance Statement

Section 2 (Conformance Statement), which specifies the GEHC equipment compliance to the DICOM requirements.

Section 3 (RTSS Information Object Implementation), which specifies the GEHC equipment description of the implementation of the RTSS information Object.

1.2 OVERALL DICOM CONFORMANCE STATEMENT DOCUMENT STRUCTURE

GEHC DICOM Conformance Statements

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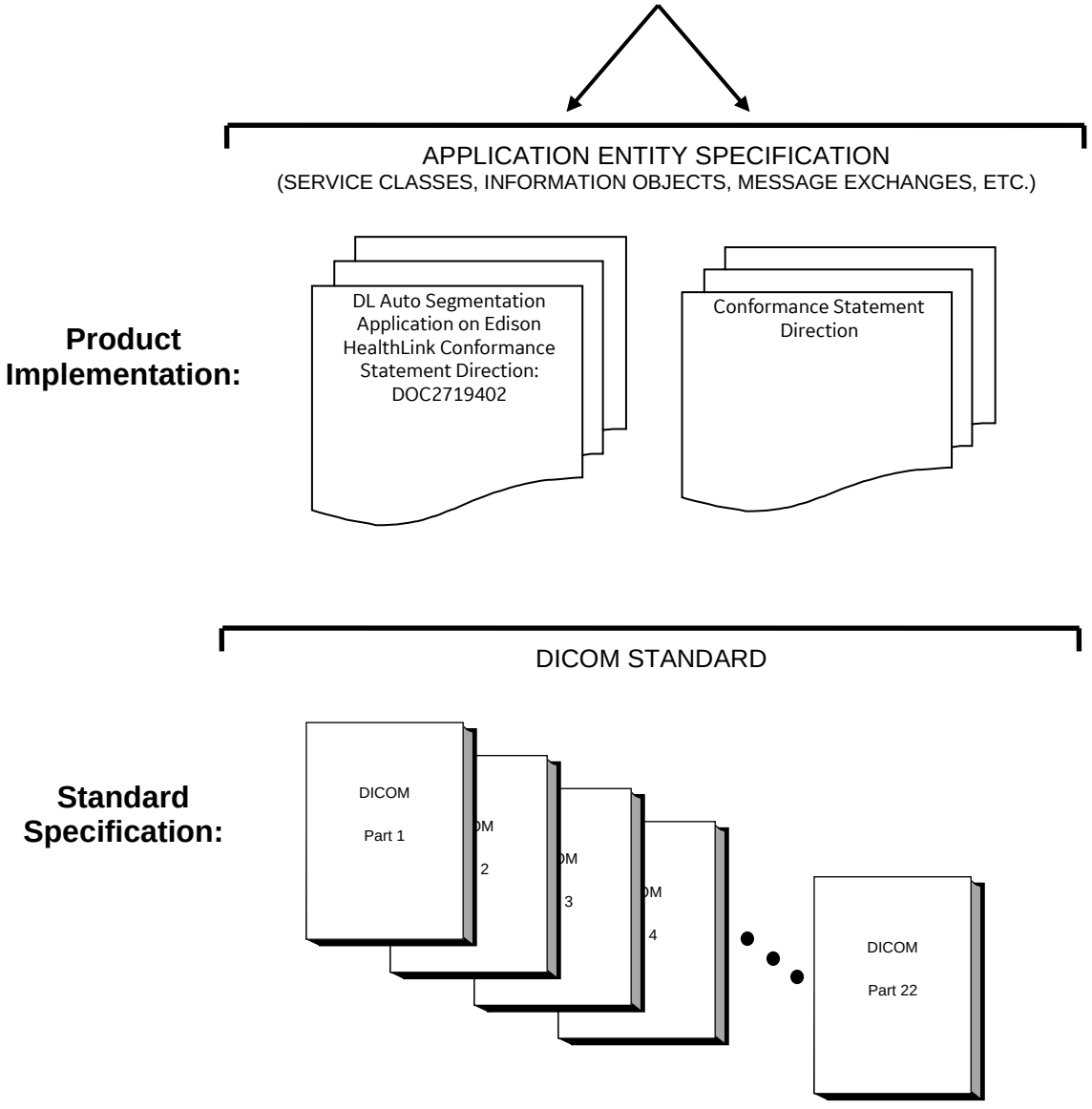
https://www.gehealthcare.com/products/interoperability/dicom



This document specifies the DICOM implementation. It is entitled:

Auto Segmentation Application on Edison HealthLink
Conformance Statement for DICOM Direction **DOC2719402**

This DICOM Conformance Statement documents the DICOM Conformance Statement and Technical Specification required to interoperate with the GEHC network interface.

The GEHC Conformance Statement, contained in this document, also specifies the Lower Layer communications which it supports. However, the Technical Specifications are defined in the DICOM Part 8 standard.

For more information regarding DICOM, copies of the Standard may be obtained on the Internet at http://medical.nema.org. Comments on the Standard may be addressed to:

DICOM Secretariat
NEMA
1300 N. 17th Street, Suite 1752
Rosslyn, VA 22209
USA
Phone: +1.703.841.3200

Note: The Auto Segmentation application is available on Edison HealthLink. The DICOM Conformance Statement can be found at the following website:

https://www.gehealthcare.com/products/interoperability/dicom

Product	**DICOM Conformance Statement Reference**
Auto Segmentation	DICOM conformance statement for Auto Segmentation Direction DOC2719402
Edison HealthLink	EHL DICOM Conformance Statement Direction DOC2193822 Rev.5 or later

1.3 INTENDED AUDIENCE

The reader of this document is concerned with software design and/or system integration issues. It is assumed that the reader of this document is familiar with the DICOM Standard and with the terminology and concepts which are used in that Standard.

1.4 SCOPE AND FIELD OF APPLICATION

It is the intent of this document to provide an unambiguous specification for GEHC implementations. This specification, called a Conformance Statement, includes a DICOM Conformance Statement and is necessary to ensure proper processing and interpretation of GEHC medical data exchanged using DICOM. The GEHC Conformance Statements are available to the public.

The reader of this DICOM Conformance Statement should be aware that different GEHC devices are capable of using different Information Object Definitions. For

example, a GEHC CT Scanner may send images using the CT Information Object, MR Information Object, Secondary Capture Object, etc.

Included in this DICOM Conformance Statement are the Module Definitions which define all data elements used by this GEHC implementation. If the user encounters unspecified private data elements while parsing a GEHC Data Set, the user is well advised to ignore those data elements (per the DICOM standard). Unspecified private data element information is subject to change without notice. If, however, the device is acting as a "full fidelity storage device", it should retain and re-transmit all of the private data elements which are sent by GEHC devices.

1.5 IMPORTANT REMARKS

The use of these DICOM Conformance Statements, in conjunction with the DICOM Standards, is intended to facilitate communication with GE imaging equipment. However, **by itself, it is not sufficient to ensure that inter-operation will be successful**. The **user (or user's agent)** needs to proceed with caution and address at least four issues:

- **Integration** - The integration of any device into an overall system of interconnected devices goes beyond the scope of standards (DICOM), and of this introduction and associated DICOM Conformance Statements when interoperability with non-GE equipment is desired. The responsibility to analyze the applications requirements and to design a solution that integrates GE imaging equipment with non–GE systems is the **user's** responsibility and should not be underestimated. The **user** is strongly advised to ensure that such an integration analysis is correctly performed.

- **Validation** - Testing the complete range of possible interactions between any GE device and non–GE devices, before the connection is declared operational, should not be overlooked. Therefore, the **user** should ensure that any non–GE provider accepts full responsibility for all validation required for their connection with GE devices. This includes the accuracy of the image data once it has crossed the interface between the GE imaging equipment and the non–GE device and the stability of the image data for the intended applications.

  Such a validation is required before any clinical use (diagnosis and/or treatment) is performed. It applies when images acquired on GE imaging equipment are processed/displayed on a non-GE device, as well as when images acquired on non-GE equipment is processed/displayed on a GE console or workstation.

- **Future Evolution** - GE understands that the DICOM Standard will evolve to meet the user's growing requirements. GE is actively involved in the development of the DICOM Standard. DICOM will incorporate new features and technologies and GE may follow the evolution of the Standard. The GEHC protocol is based on DICOM as specified in each DICOM Conformance Statement. Evolution of the Standard may require changes to devices which have implemented DICOM. **In addition, GE reserves the right to discontinue or make changes to the support of communications features (on its products) described by these DICOM Conformance Statements**. The **user** should ensure that any non–GE provider, which connects with GE devices, also plans for the future evolution of the DICOM Standard. Failure to do so will likely result in the loss of function and/or connectivity as the DICOM Standard changes and GE Products are enhanced to support these changes.

- **Interaction** - It is the sole responsibility of the **non–GE provider** to ensure that communication with the interfaced equipment does not cause degradation of GE imaging equipment performance and/or function.

1.6 REFERENCES

NEMA PS3	Digital Imaging and Communications in Medicine (DICOM) Standard, available free at http://medical.nema.org/
EHL DCS	Edison HealthLink DICOM Conformance Statement, direction number DOC2193822 Rev.5 or later

1.7 DEFINITIONS

Informal definitions are provided for the following terms used in this Conformance Statement. The DICOM Standard is the authoritative source for formal definitons of these terms.

Abstract Syntax – the information agreed to be exchanged between applications, generally equivalent to a Service/Object Pair (SOP) Class. Examples : Verification SOP Class, Modality Worklist Information Model Find SOP Class, Computed Radiography Image Storage SOP Class.

Application Entity (AE) – an end point of a DICOM information exchange, including the DICOM network or media interface software; i.e., the software that sends or receives DICOM information objects or messages. A single device may have multiple Application Entities.

Application Entity Title – the externally known name of an *Application Entity*, used to identify a DICOM application to other DICOM applications on the network.

Application Context – the specification of the type of communication used between *Application Entities*. Example: DICOM network protocol.

Association – a network communication channel set up between *Application Entities*.

Attribute – a unit of information in an object definition; a data element identified by a *tag*. The information may be a complex data structure (Sequence), itself composed of lower level data elements. Examples: Patient ID (0010,0020), Accession Number (0008,0050), Photometric Interpretation (0028,0004), Procedure Code Sequence (0008,1032).

Information Object Definition (IOD) – the specified set of *Attributes* that comprise a type of data object; does not represent a specific instance of the data object, but rather a class of similar data objects that have the same properties. The *Attributes* may be specified as Mandatory (Type 1), Required but possibly unknown (Type 2), or Optional (Type 3), and there may be conditions associated with the use of an Attribute (Types 1C and 2C). Examples: CT Image IOD for single CT Image series (SOP class UID 1.2.840.10008.5.1.4.1.1.2)

Module – a set of *Attributes* within an *Information Object Definition* that are logically related to each other. Example: Patient Module includes Patient Name, Patient ID, Patient Birth Date, and Patient Sex.

Negotiation – first phase of *Association* establishment that allows *Application Entities* to agree on the types of data to be exchanged and how that data will be encoded.

Presentation Context – the set of DICOM network services used over an *Association*, as negotiated between *Application Entities*; includes *Abstract Syntaxes* and *Transfer Syntaxes*.

Service Class Provider (SCP) – role of an *Application Entity* that provides a DICOM network service; typically, a server that performs operations requested by another *Application Entity* (*Service Class User*). Examples: Picture Archiving and Communication System (image storage SCP, and image query/retrieve SCP), Radiology Information System (modality worklist SCP).

Service Class User (SCU) – role of an *Application Entity* that uses a DICOM network service; typically, a client. Examples: imaging modality (image storage SCU, and modality worklist SCU), imaging workstation (image query/retrieve SCU)

Service/Object Pair (SOP) Class – the specification of the network or media transfer (service) of a particular type of data (object); the fundamental unit of DICOM interoperability specification. Examples: Ultrasound Image Storage Service, Basic Grayscale Print Management.

Service/Object Pair (SOP) Instance – an information object; a specific occurrence of information exchanged in a *SOP* Class. Examples: a specific x-ray image.

Tag – a 32-bit identifier for a data element, represented as a pair of four digit hexadecimal numbers, the "group" and the "element". If the "group" number is odd, the tag is for a private (manufacturer-specific) data element. Examples: (0010,0020) [Patient ID], (07FE,0010) [Pixel Data], (0019,0210) [private data element]

Transfer Syntax – the encoding used for exchange of DICOM information objects and messages. Examples: To Explicit little endian transfer syntax

Unique Identifier (UID) – a globally unique "dotted decimal" string that identifies a specific object or a class of objects; an ISO-8824 Object Identifier. Examples: Study Instance UID, SOP Class UID, SOP Instance UID.

Value Representation (VR) – the format type of an individual DICOM data element, such as text, an integer, a person's name, or a code. DICOM information objects can be transmitted with either explicit identification of the type of each data element (Explicit VR), or without explicit identification (Implicit VR); with Implicit VR, the receiving application must use a DICOM data dictionary to look up the format of each data element.

1.8 SYMBOLS AND ABBREVIATIONS

AE	Application Entity
AET	Application Entity Title
CR	Computed Radiography
CT	Computed Tomography
DHCP	Dynamic Host Configuration Protocol
DICOM	Digital Imaging and Communications in Medicine
IOD	Information Object Definition
ISO	International Organization for Standards
O	Optional (Key Attribute)

R	Required (Key Attribute)
RT	Radiotherapy
SC	Secondary Capture
SCP	Service Class Provider
SCU	Service Class User
SOP	Service-Object Pair
TCP/IP	Transmission Control Protocol/Internet Protocol
U	Unique (Key Attribute)
VR	Value Representation
RTSS	Radiotherapy Structure Set

2. CONFORMANCE STATEMENT

Auto Segmentation application on Edison Health Link generates DICOM RTSS from Input Single CT Series having SOP class UID 1.2.840.10008.5.1.4.1.1.2. The generated RTSS images are sent back to CT Console/Workstation from Edison Health Link.

The goal of this document is to give a detailed description of the DICOM RTSS that are generated by the Auto Segmentation Applications (section 3).

2.1 IMPLEMENTATION IDENTIFYING INFORMATION

Auto Segmentation application receives single CT series (having SOP class UID 1.2.840.10008.5.1.4.1.1.2) from CT scanners which are connected to the Edison Health Link system. Please refer to the DICOM conformance statement (See section 1.2 in this document).

2.2 SUPPORT OF EXTENDED CHARACTER SETS

The Defined Terms for Specific Character Set are defined by following Table:

TABLE 2.2-1
SUPPORTED SPECIFIC CHARACTER SET DEFINED TERMS

Defined Term	Character Set Description
ISO_IR 100	Latin alphabet No. 1
ISO_IR 6	Default repertoire

2.3 AE Specifications

2.3.1 DICOM SERVER AE Specification

Auto Segmentation Application provides Standard or Standard Extended Conformance to the following DICOM SOP Classes as an SCU and / or as an SCP:

Table 2.3–1
Supported SOP Classes

SOP Class Name	SOP Class UID	SCU	SCP
		Object output (write)	Object Input (read)
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	Yes	No

3. RT STRUCTURE SET INFORMATION OBJECT IMPLEMENTATION

3.1 INTRODUCTION

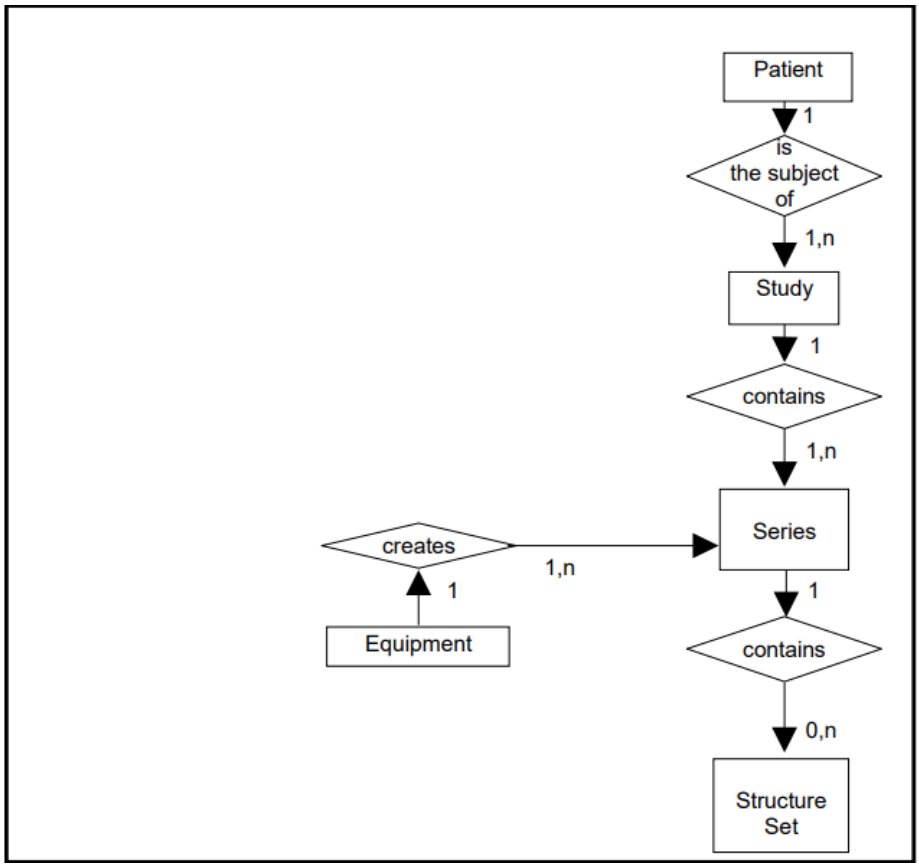
This section describes the RT Structure Set Information Object Implementation generated from Auto Segmentation.

3.2 RTSS ENTITY RELATIONSHIP MODEL

The Entity-Relationship diagram for the RTSS interoperability schema is shown in the illustration below. In this figure, the following diagrammatic convention is established to represent the information organization:

- each entity is represented by a rectangular box
- each relationship is represented by a diamond shaped box.
- the fact that a relationship exists between two entities is depicted by lines connecting the corresponding entity boxes to the relationship boxes.

The relationships are fully defined with the maximum number of possible entities in the relationship shown. In other words, the relationship between Series and RTSS can have up to n RTSSs per Series, but the Patient to Study relationship has 1 Patient for each Study (a Patient can have more than one Study on the system, however each Study will contain all of the information pertaining to that Patient).



3.2.1 ENTITY DESCRIPTIONS

Please refer to DICOM Standard Part 3 (Information Object Definitions) for a description of each of the entities contained within the RTSS Information Object

3.2.2 Auto Segmentation Mapping of DICOM entities

TABLE 3.2-1
MAPPING OF DICOM ENTITIES TO AUTO SEGMENTATION ENTITIES

DICOM	Auto Segmentation Entity
Patient	Patient
Study	Study
Series	Series
Structure Set	Structure Set

3.3 IOD MODULE TABLE

Within an entity of the DICOM RTSS IOD, attributes are grouped into related set of attributes. A set of related attributes is termed a module. A module facilitates the understanding of the semantics concerning the attributes and how the attributes are

related with each other. A module grouping does not infer any encoding of information into datasets.

The table below identifies the defined modules within the entities which comprise the DICOM RTSS IOD. Modules are identified by Module Name. See DICOM Part 3 for a complete definition of the entities, modules, and attributes. The RT Structure Set Information Object Implementation comprises the modules of the following tables.

TABLE 3.3-1
RTSS IOD MODULES

Entity Name	Module Name	Reference	Usage
Patient	Patient	3.4.2	Used
	Clinical Trial Subject	N/A	Not Used
Study	General Study	3.4.3	Used
	Patient Study	N/A	Not Used
	Clinical Trial Study	N/A	Not Used
Series	RT Series	3.4.4	Used
	Clinical Trial Series	N/A	Not Used
Equipment	General Equipment	3.4.5	Used
Structure Set	Structure Set	3.4.6	Used
	ROI Contour	3.4.7	Used
	RT ROI Observations	3.4.8	Used
	Approval	N/A	Not Used
SOP Common	SOP Common	3.4.1	Used

3.4 RT STRUCTURE SET INFORMATION MODULE DEFINITIONS

Please refer to DICOM Part 3 (Information Object Definitions) for a description of each of the entities, modules, and attributes contained within the RTSS Information Objects.

If an element is not listed below, it means that it will not be copied at writing.

3.4.1 SOP COMMON MODULE ATTRIBUTES C.12.1

Attribute Name	Element Tag	Type	Notes
Specific Character Set	(0008,0005)	1C	Copied
SOP Class UID	(0008,0016)	1	“1.2.840.10008.5.1.4.1.1.481.3”
SOP Instance UID	(0008,0018)	1	Generated **Note**: SOP Instance UID follows a standard format **<root>.<suffix>** where root is the GE root ID i.e., **1.2.840.113619.2.512** and suffix is the timestamp.

3.4.2 PATIENT MODULE ATTRIBUTES C.7.1.1

Attribute Name	Element Tag	Type	Notes
Patient's Name	(0010,0010)	2	Copied
Patient's ID	(0010,0020)	2	Copied
Patient's Birth Date	(0010,0030)	2	Copied
Patient's Sex	(0010,0040)	2	Copied

3.4.3 GENERAL STUDY MODULE ATTRIBUTES C.7.2.1

Attribute Name	Element Tag	Type	Notes
Study Instance UID	(0020,000D)	1	Copied
Study Date	(0008,0020)	2	Copied
Study Time	(0008,0030)	2	Copied
Referring Physician's Name	(0008,0090)	2	Copied
Study ID	(0020,0010)	2	Copied
Accession Number	(0008,0050)	2	Copied
Study Description	(0008,1030)	3	Copied

3.4.4 RT SERIES MODULE ATTRIBUTES C.8.8.1

Attribute Name	Element Tag	Type	Notes
Modality	(0008,0060)	1	"RTSTRUCT"
Operator's Name	(0008,1070)	2	""
Series Number	(0020,0011)	2	In case input Series Number in empty or unknown then it is copied as is otherwise it will be set to Input Series Number + 1000
Series Instance UID	(0020,000E)	1	Generated **Note**: Series Instance UID follows a standard format **<root>.<suffix>** where root is the GE root ID i.e., **1.2.840.113619.2.512** and suffix is the timestamp.
Series Description	(0008,103E)	3	"Generated structures"

3.4.5 GENERAL EQUIPMENT MODULE ATTRIBUTES C.7.5.1

Attribute Name	Element Tag	Type	Notes
Manufacturer	(0008,0070)	2	"GE"

Manufacturer's Model Name	(0008,1090)	3	"GE Healthcare rtssconv"
Software Versions	(0018,1020)	3	Generated

3.4.6 STRUCTURE SET MODULE ATTRIBUTES C.8.8.5

Attribute Name	Element Tag	Type	Notes
Structure Set Label	(3006,0002)	1	"Automatically generated structures"
Structure Set Date	(3006,0008)	2	Generated: current date
Structure Set Time	(3006,0009)	2	Generated: current time
Structure Set ROI Sequence	(3006,0020)	1	Contains items corresponding to the ROIs
>ROI Number	(3006,0022)	1	Generated
>Referenced Frame Of Reference UID	(3006,0024)	1	Copied
>ROI Name	(3006,0026)	2	Based on the profile created / updated in Profile Browser User Interface
>ROI Generation Algorithm	(3006,0036)	2	"AUTOMATIC"
Referenced Frame Of Reference Sequence	(3006,0010)	3	Contains items corresponding to the CT series of the ROIs.
>Frame Of Reference UID	(0020,0052)	1	Copied
>RT Referenced Study Sequence	(3006,0012)	3	Sequence contains one item, corresponding to the study containing the series of the ROIs
>>Referenced SOP Class UID	(0008,1150)	1	"1.2.840.10008.3.1.2.3.1"
>>Referenced SOP Instance UID	(0008,1155)	1	Copied
>>RT Referenced Series Sequence	(3006,0014)	1	Contains items corresponding to the referenced series
>>>Series Instance UID	(0020,000E)	1	Copied
>>>Contour Image Sequence	(3006,0016)	1	Sequence will contain all images in the series, even if some or all images have got no corresponding contour.
>>>>Referenced SOP Class UID	(0008,1150)	1	Copied
>>>>Referenced SOP Instance UID	(0008,1155)	1	Copied

3.4.7 ROI CONTOUR MODULE ATTRIBUTES C.8.8.6

Attribute Name	Element Tag	Type	Notes

ROI Contour Sequence	(3006,0039)	1	Each item in it corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020).
>Referenced ROI Number	(3006,0084)	1	The ROI Number the contour corresponds to
>ROI Display Color	(3006,002A)	3	Based on the profile created / updated in Profile Browser User
>Contour Sequence	(3006,0040)	3	Provided if ROI has contour.
>>Contour Number	(3006,0048)	3	Corresponds to the polygons computed from segmentations
>>Contour Geometric Type	(3006,0042)	1	"CLOSED_PLANAR"
>>Number Of Contour Points	(3006,0046)	1	Generated
>> Contour Data	(3006,0050)	1	List of coordinates of the points in the contour. Positions are given in DICOM coordinate system; Z coordinates always fit the referenced acquisition slice.
>>Contour Image Sequence	(3006,0016)	3	Sequence will always contain exactly one item (referenced CT image)
>>>Referenced SOP Class UID	(0008,1150)	1	Copied
>>>Referenced SOP Instance UID	(0008,1155)	1	Copied

3.4.8 RT ROI OBSERVATIONS MODULE ATTRIBUTES C.8.8.8

Attribute Name	Element Tag	Type	Notes
RT ROI Observations Sequence	(3006,0080)	1	Each item corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020).
>Observation Number	(3006,0082)	1	Index of the ROI the observation sequence corresponds to
>Referenced ROI Number	(3006,0084)	1	Index of the ROI the observation sequence corresponds to
>RT ROI Interpreted Type	(3006,00A4)	2	Value is set to EXTERNAL in case of body contour otherwise ORGAN
>ROI Interpreter	(3006,00A6)	2	""