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GE Medical Systems

Technical Publications

Direction 2328880-100
Revision 0

Advanced Lung Analysis CONFORMANCE STATEMENT for DICOM V3.0

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TABLE OF CONTENTS

1. INTRODUCTION

1.1 OVERVIEW

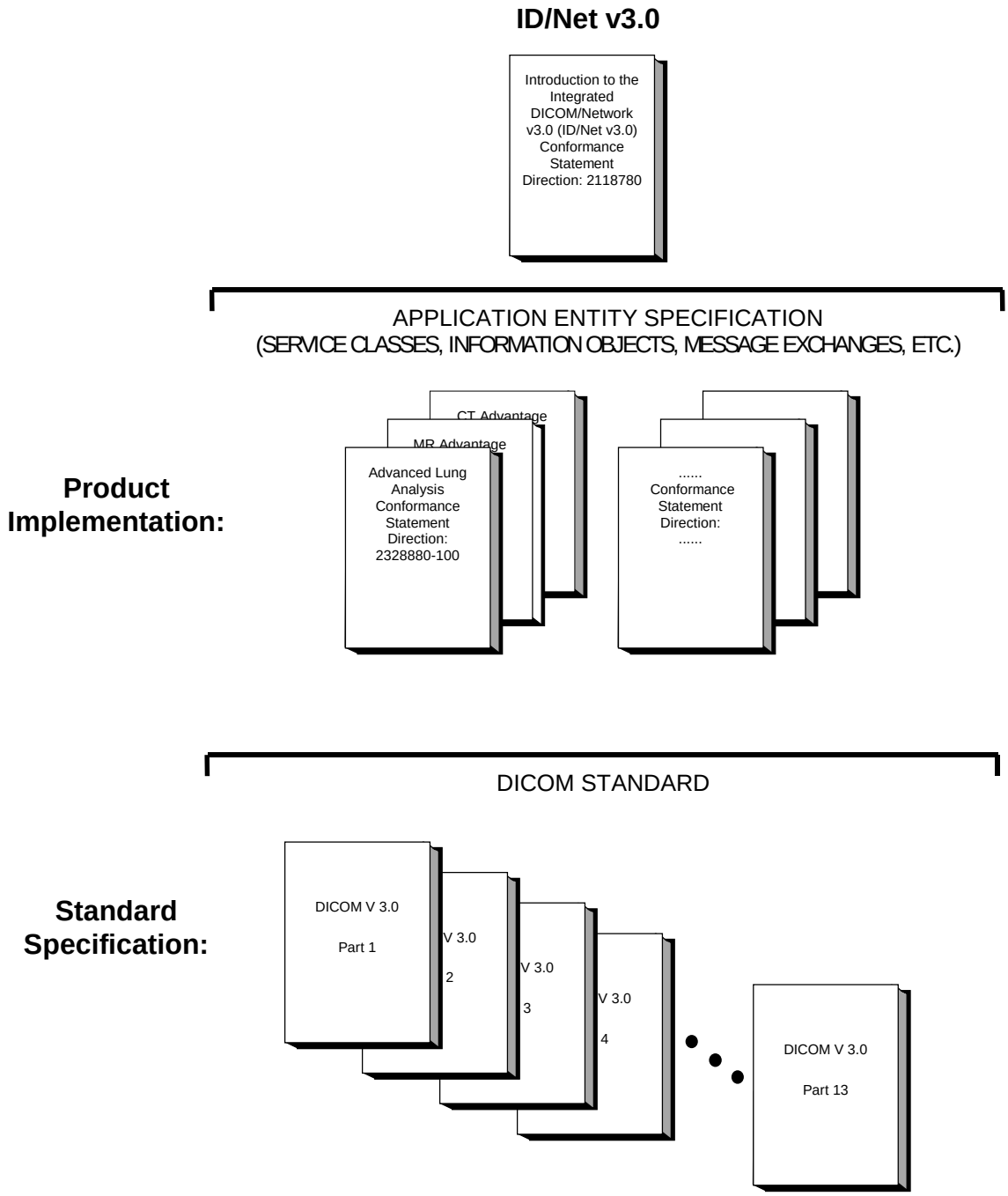
This DICOM Conformance Statement is divided into Sections as described below:

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

Section 2 (RT Structure set information object implementation (as SCU) and requirements (as SCP)), which specifies the use of the DICOM RT Structure set IOD to represent the information included in structure sets produced by this implementation, and also specifies the requirements for the RT Structure Set IOD when being used as input to Lung Cancer management prototype.

1.2 OVERALL DICOM CONFORMANCE STATEMENT DOCUMENT STRUCTURE

The Documentation Structure of the GEMS Conformance Statements and their relationship with the DICOM v3.0 Conformance Statements is shown in the Illustration below.



This document specifies the DICOM v3.0 implementation. It is entitled:

Advanced Lung Analysis
Conformance Statement for DICOM v3.0
*Direction **2328880-100***

This DICOM Conformance Statement documents the DICOM v3.0 Conformance Statement and Technical Specification required to interoperate with the GEMS network interface. Introductory information, which is applicable to all GEMS Conformance Statements, is described in the document:

Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0)
Conformance Statement
Direction: 2118780.

This Introduction familiarizes the reader with DICOM terminology and general concepts. It should be read prior to reading the individual products' GEMS Conformance Statements.

The GEMS Conformance Statement, contained in this document, also specifies the Lower Layer communications, which it supports (e.g., TCP/IP). However, the Technical Specifications are defined in the DICOM v3.0 Part 8 standard.

For more information including Network Architecture and basic DICOM concepts, please refer to the Introduction.

For the convenience of software developers, there is "collector" Direction available. By ordering the collector, the Introduction described above and all of the currently published GEMS Product Conformance Statements will be received. The collector Direction is:

ID/Net v3.0 Conformance Statements
Direction: 2117016

For more information regarding DICOM v3.0, copies of the Standard may be obtained by written request or phone by contacting:

NEMA Publication
1300 North 17th Street
Suite 1847
Rosslyn, VA 22209
USA
Phone: (703) 841-3200

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 v3.0 Standards and with the terminology and concepts which are used in those Standards.

If readers are unfamiliar with DICOM v3.0 terminology they should first refer to the document listed below, then read the DICOM v3.0 Standard itself, prior to reading this DICOM Conformance Statement document.

Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0)
Conformance Statement
Direction: 2118780

1.4 SCOPE AND FIELD OF APPLICATION

It is the intent of this document, in conjunction with the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780*, to provide an unambiguous specification for GEMS implementations. This specification, called a Conformance Statement, includes a DICOM v3.0 Conformance Statement and is necessary to ensure proper processing and interpretation of GEMS medical data exchanged using DICOM v3.0. The GEMS Conformance Statements are available to the public.

The reader of this DICOM Conformance Statement should be aware that different GEMS devices are capable of using different Information Object Definitions. For example, a GEMS 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 GEMS implementation. If the user encounters unspecified private data elements while parsing a GEMS Data Set, the user is well advised to ignore those data elements (per the DICOM v3.0 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 GEMS devices.

1.5 IMPORTANT REMARKS

The use of these DICOM Conformance Statements, in conjunction with the DICOM v3.0 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 v3.0), 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 v3.0 Standard. DICOM v3.0 will incorporate new features and technologies and GE may follow the evolution of the Standard. The GEMS protocol is based on DICOM v3.0 as specified in each DICOM Conformance Statement. Evolution of the Standard may require changes to devices which have implemented DICOM v3.0. **In addition, GE reserves the right to discontinue or make changes to the support of communications features (on its products) reflected on 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.

- **To be informed of the evolution of the implementation described in this document, the User is advised to regularly check the GE Internet Server, accessible via anonymous ftp (GE Internet Server Address: ftp.med.ge.com, 192.88.230.11).**

- **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

A list of references which is applicable to all GEMS Conformance Statements is included in the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780*.
The information object implementation refers to DICOM PS 3.3 (Information Object Definition).

1.7 DEFINITIONS

A set of definitions which is applicable to all GEMS Conformance Statements is included in *the Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780*.

1.8 SYMBOLS AND ABBREVIATIONS

A list of symbols and abbreviations which is applicable to all GEMS Conformance Statements is included in the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780.*

2. RT STRUCTURE SET INFORMATION OBJECT IMPLEMENTATION (AS SCU) AND REQUIREMENTS (AS SCP)

2.1 INTRODUCTION

This section specifies the use of the DICOM RT Structure Set IOD to represent the information included in structure sets produced by this implementation, and also specifies the requirements for the RT Structure Set IOD when being used as input to Lung Cancer management prototype. Corresponding attributes are conveyed using the module construct.

Lung Cancer application implements the RT Structure Set IOD as a Standard Extended object, containing additional elements defined in the Structure Set Module (see Section 5-4-5 of this document). These attributes are:

These attributes are provided for enhanced functionality when reading RT Structure Sets created by the Lung Cancer application itself. They should not be ignored by SCP implementations interpreting these objects. These attributes are required in RT Structure Sets created by SCU implementations for use in Lung Cancer application.

Note: This implementation of the RT Structure Set IOD contains the attribute Instance Number (0020,0013), formerly known as Image Number, added to the RT Structure Set object definition in September 1999 (Change Proposals CP-134 and CP-99).

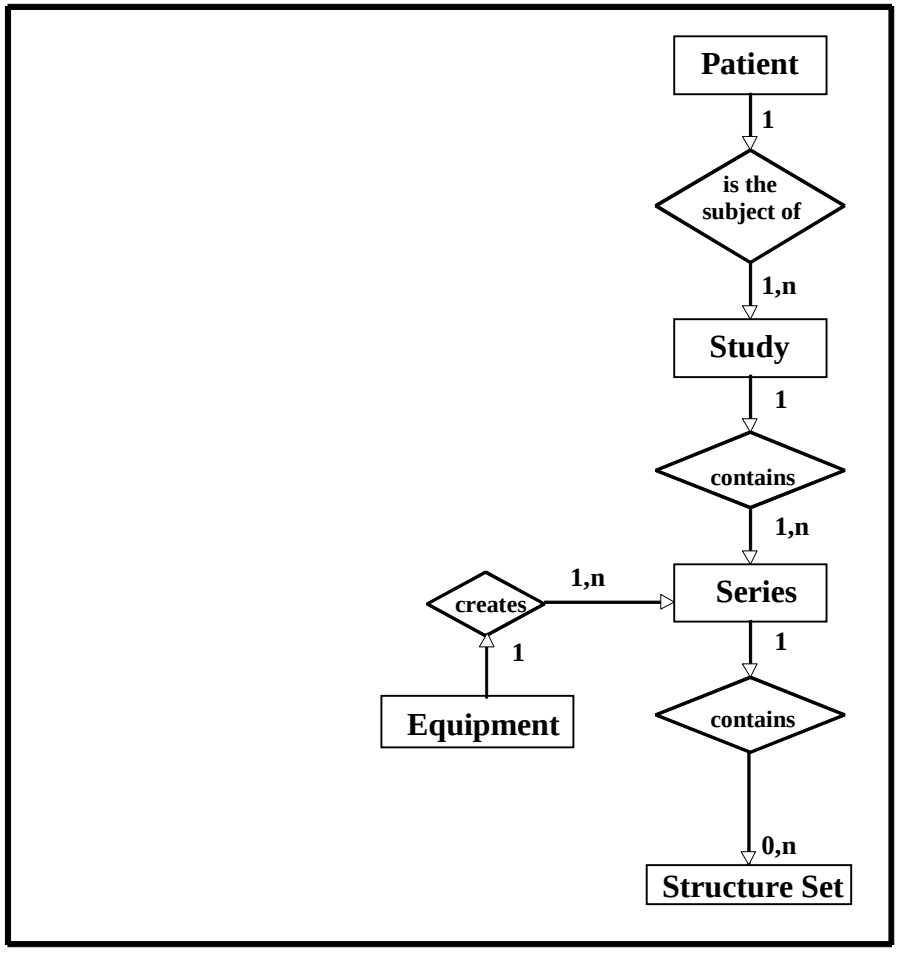
2.2 RT STRUCTURE SET IOD IMPLEMENTATION

This section defines the implementation of the RT Structure Set information object in the Lung Cancer application. It refers to the DICOM Standard 1998 Part 3 (Information Object Definitions).

In the following tables, notes are provided for when Lung Cancer application is acting as a producer of objects (SCU), and a consumer of objects (SCP). Notes in UPPER CASE LETTERS represent restrictions on object contents imposed by the application when acting as an SCP (object consumer).

2.3 RT STRUCTURE SET IOD ENTITY-RELATIONSHIP MODEL

ILLUSTRATION **2.3-1**
RT STRUCTURE SET ENTITY RELATIONSHIP DIAGRAM



The Entity-Relationship diagram for the RT Structure Set interoperability schema is shown in Illustration 2.3-1. 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. See DICOM Part 3 Section 5.1.2 for an explanation of the entity-relationship notation.

2.3.1 Entities Description

Refer to DICOM Standard Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Structure Set information object.

2.3.2 ALA Mapping of DICOM entities

DICOM entities map to the ALA entities in the following manner:

DICOM	ALA
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Equipment Entity	Workstation on which Lung Cancer application is running
Structure Set	Lung Cancer geometric information relating to defined nodules

2.4 RT Structure Set IOD Module Table

Within an entity of the DICOM RT Structure Set Information Object Definition, 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.

Table 2.4-1 identifies the defined modules within the entities which comprise the DICOM RT Structure Set Information Object Definition. Modules are identified by Module Name.

See DICOM Standard Part 3 for a complete definition of the entities, modules, and attributes.

TABLE 2.4-1
RT STRUCTURE SET INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference Section
Patient	Patient	M	2.5.1.1
Study	General Study	M	2.5.2.1
	Patient Study	U	not used
Series	RT Series	M	2.5.3.1
Equipment	General Equipment	M	2.5.4.1
Structure Set	Structure Set	M	2.5.5.1
	ROI Contour	M	2.5.5.2
	RT ROI Observations	M	2.5.5.3
	Approval	U	not used
	Audio	U	not used
	SOP Common	M	2.5.5.4

2.5 INFORMATION MODULE DEFINITIONS

Please refer to DICOM Standard Part 3 (Information Object Definitions) for a description of each of the entities and modules contained within the RT Structure Set Information Object.

2.5.1 Patient Entity Modules

2.5.1.1 Patient Module

Attribute Name	Tag	Type	Attribute description
Patient's Name	(0010,0010)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length. SCP: Used for display and database key. NON-NULL VALUE REQUIRED BY ANY APPLICATION FOR SAFE PATIENT IDENTIFICATION.
Patient ID	(0010,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for display and database key. NON-NULL VALUE STRONGLY RECOMMENDED FOR SAFE PATIENT IDENTIFICATION.
Patient's Birth Date	(0010,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for database key if non-null. Use of identical value to that found in acquisition images is recommended.
Patient's Sex	(0010,0040)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for database key if non-null. Use of identical value to that found in acquisition images is recommended.
Ethnic Group	(0010,2160)	3	SCU: Not yet implemented SCP: Not used
Patient Comments	(0010,4000)	3	SCU: Patient demographic data: Stored in an XML format. Define patient smoking history, family history, respiratory symptoms history, pre-examination comments, reason for exam. In general, this field contains patient demographics that can be entered before the patient has the scan or examination. SCP: Not used

2.5.2 Study Entity Modules

2.5.2.1 General Study

Attribute Name	Tag	Type	Attribute description
Study Instance UID	(0020,000D)	1	SCU: Duplicated from patient model images

			SCP: Not used
Study Date	(0008,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used
Study Time	(0008,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used
Referring Physicians' Name	(0008,0090)	2	SCU: Zero-length SCP: Not used
Study ID	(0020,0010)	2	SCU: Duplicated from patient model images SCP: NON-NULL VALUE REQUIRED BY APPLICATION FOR OBJECT IDENTIFICATION
Accession number	(0008,0050)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used

2.5.3 Series Entity Modules

2.5.3.1 RT Series

Attribute Name	Tag	Type	Attribute description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data. Enumerated Values: SCU: 'RTSTRUCT' SCP: Must only be 'RTSTRUCT' (DICOM requirement)
Series Instance UID	(0020,000E)	1	SCU: Duplicated from CT examination SOP instance UID + .103. Trimmed to 64 characters if necessary by removing from the front SCP: Not used
Series Number	(0020,0011)	2	SCU: 103 SCP: Used for display if non-null
Series Description	(0008,103E)	3	SCU: 'ALA RT Structure Sets' SCP: Used for display if provided

2.5.4 Equipment Entity Modules

2.5.4.1 General Equipment

Attribute Name	Tag	Type	Attribute description
Manufacturer	(0008,0070)	2	SCU: 'GE MEDICAL SYSTEMS' SCP: Used to determine system creating object and for display, if non-null (recommended for clear identification of creating system)

Station Name	(0008,1010)	3	SCU: Host name SCP: Not used
Manufacturer's Model Name	(0008,1090)	3	SCU: 'ALA' SCP: Used to determine system creating object and for display, if provided (recommended for clear identification of creating system)
Device Serial Number	(0018,1000)	3	SCU: Workstation UID (Unix command hostid) SCP: Not used
Software Versions	(0018,1020)	3	SCU: 'X.Y (single-valued) ie 1.1 SCP: Used to determine system creating object and for display, if provided (recommended for clear identification of creating system)

2.5.5 Structure Set Entity Modules

2.5.5.1 Structure Set

Attribute Name	Tag	Type	Attribute description
Structure Set Label	(3006,0002)	1	SCU: ALA SCP: Not used.
Structure Set Name	(3006,0004)	3	SCU: User comment or Autosave SCP: Used for display and object identification
Instance Number	(0020,0013)	3	SCU: Zero Length SCP: Used for display if provided
Structure Set Date	(3006,0008)	2	SCU: Date at moment object was saved SCP: Used for display if non-null
Structure Set Time	(3006,0009)	2	SCU: Time at moment object was saved SCP: Used for display if non-null
Referenced Frame of Reference Sequence	(3006,0010)	*3*	SCU: Sequence will contain items, corresponding to all reference sequences used to monitor nodule(s) over time SCP: MUST CONTAIN ONE OR MORE ITEMS, EXACTLY ONE OF WHICH MUST BE REFERENCED BY ALL ROIS
>Frame of Reference UID	(0020,0052)	1C	SCU: Duplicated from CT images SCP: FOR THE ITEM REFERENCED BY ROIS, MUST CORRESPOND TO FRAME OF REFERENCE UID (0020,0052) OF ACQUISITION IMAGES
>RT Referenced Study Sequence	(3006,0012)	3	SCU: Sequence will always contain exactly one item, corresponding to the Study containing the CT images SCP: MUST CONTAIN ONE OR MORE ITEMS, EXACTLY ONE OF WHICH MUST BE REFERENCED BY ROIS

>>Referenced SOP Class UID	(0008,1150)	1C	SCU: Duplicated from CT images SCP: Not used
>>Referenced SOP Instance UID	(0008,1155)	1C	SCU: Duplicated from CT images if present in those images, otherwise a unique UID will be created by the application SCP: Not used
>>RT Referenced Series Sequence	(3006,0014)	1C	SCU: Sequence will always contain exactly one item, corresponding to the Series containing the CT images SCP: FOR THE ITEM REFERENCED BY ROIS, MUST CORRESPOND TO CT IMAGE SERIES
>>>Series Instance UID	(0020,000E)	1C	SCU: Duplicated from CT images if present in those images, otherwise a unique UID will be created by the application SCP: Not used
>>>Contour Image Sequence	(3006,0016)	1C	SCU: Sequence will contain all CT images used to build the 3D patient model, SCP: For the RT Referenced Series Sequence item referenced by ROIs, all images will be used to construct 3D model, even if they do not contain contour or marker. AT LEAST FIVE IMAGE ITEMS MUST BE PROVIDED. SPACING BETWEEN IMAGES IS STRONGLY RECOMMENDED TO BE LESS THAN 10 MM FOR ADEQUATE 3D MODEL RECONSTRUCTION.
>>>>Referenced SOP Class UID	(0008,1150)	1C	SCU: Always equal to CT Image SOP Class SCP: Must be equal to CT Image SOP Class
>>>>Referenced SOP Instance UID	(0008,1155)	1C	SCU: Always provided SCP: Required to locate referenced images in AW database
Structure Set ROI Sequence	(3006,0020)	3	SCU: Always provided unless there have been no structures, in which case the sequence will be absent SCP: There is no practical limit to the number of structures. This sequence may also be empty (no structures defined).
>ROI Number	(3006,0022)	1C	SCU: Number structures in increasing numeric order, starting from 1, as they are found in the plan SCP: Not used
>Referenced Frame of Reference UID	(3006,0024)	1C	SCU: Equal to Frame of corresponding frame of reference UID (0020,0052) above SCP: MUST BE EQUAL TO EXACTLY ONE FRAME OF REFERENCE UID (0020,0052) IN REFERENCED FRAME OF REFERENCE SEQUENCE (3006,0010). ALL ROIS MUST REFERENCE THE SAME FRAME OF REFERENCE.

>ROI Name	(3006,0026)	2C	SCU: Name is defined as a unique name per each identified nodule SCP: Needed for nodule naming convention
>ROI Description	(3006,0028)	3	SCU: User defined description for ROI: Used to describe geometrically the nodule: Length, height, external surface other attributes SCP: Not Used
>ROI Volume	(3006,002C)	3	SCU: Volume of the nodule cm3 SCP: Not Used
>ROI Generation Algorithm	(3006,0036)	2C	SCU: AUTOMATIC SCP: NEEDED FOR CVI INDEX COMPARISON CONSISTENCY
>ROI Generation Description	(3006,0038)	3	SCU: a string which describes the segmentation parameters needed to compute the volume of the nodule: CVI CVI/1.0/NoduleType/Vbox_X/ Vbox_Y/ Vbox_Z/Threshold/Kernel size/Wall object removal SCP: Optional since segmentation parameters are always automatically recomputed.

2.5.5.2 ROI Contour

Attribute Name	Tag	Type	Attribute description
ROI Contour Sequence	(3006,0039)	1	SCU: Sequence will always contain all the markers defined in the Structure Set Module, in the same sequential order SCP: Each item corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020). If none of the structures in the RT Structure Set have defined contours, then ROI Contour Sequence (3006,0039) is zero-length.
>Referenced ROI Number	(3006,0084)	1	SCU: Always provided SCP: Must correspond to exactly one ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) (DICOM requirement).
>ROI Display Color	(3006,002A)	3	SCU: Zero Length SCP: Not Used
>Contour Sequence	(3006,0040)	3	SCU: Always provided SCP: NEEDED FOR BOOKMARK LOCATION
>>Contour Geometric Type	(3006,0042)	1C	SCU: 'POINT' for markers SCP: Structures with contours other than 'POINT' will not be used by the application
>>Number of Contour Points	(3006,0046)	1C	SCU: 1 Constant value SCP: NOT USED
>>Contour Data	(3006,0050)	1C	SCU: Nodule 3D coordinates LPS. In ALA application are not restricted to lie on acquisition

			slices, and therefore their inferior/superior coordinate may take any value. SCP: Used to replace nodule

2.5.5.3 RT ROI Observations

Attribute Name	Tag	Type	Attribute description
RT ROI Observations Sequence	(3006,0080)	1	SCU: Sequence will always contain all the structures defined in the Structure Set Module, in the same sequential order SCP: Each item corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020)
>Observation Number	(3006,0082)	1	SCU: Advanced Lung Application will number observations in increasing numeric order, starting from 1 (i.e. Observation Number will correspond to ROI Number) SCP: Not used
>Referenced ROI Number	(3006,0084)	1	SCU: Always provided SCP: Must correspond to exactly one ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) (DICOM requirement)
ROI Observation Label	(3006,0085)	3	SCU: NOT USED SCP: NOT USED
ROI Observation Description	(3006,0088)	3	SCU: Per nodule clinical observations: Stored in an XML format. Half the information is computer generated such as slice index, doubling time, and screen capture UIDs. The other half of the data is entered by the user such as nodule shape, surface, and severity. SCP: NOT USED

2.5.5.4 SOP Common

Attribute Name	Tag	Type	Attribute description
SOP Class UID	(0008,0016)	1	SCU: '1.2.840.10008.5.1.4.1.1.481.3' SCP: Must be equal to '1.2.840.10008.5.1.4.1.1.481.3' (DICOM requirement)
SOP Instance UID	(0008,0018)	1	SCU: UID root will be '1.2.840.113619.2.69' SCP: Not USd
Specific Character Set	(0008,0005)	1C	SCU: 'ISO_IR 100' SCP: Specific Character Sets other than 'ISO_IR 100' are not handled explicitly by ALA
Instance Creation Date	(0008,0012)	3	SCU: Same as Structure Set Date (3006,0008) SCP: Not used
Instance Creation Time	(0008,0013)	3	SCU: Same as Structure Set Time (3006,0009)

			SCP: Not used
Instance Creator UID	(0008,0014)	3	SCU: Used to identify structure changes of the RTSS object '1.2.840.113619.6.101' ATE '1.2.840.113619.6.102' ME SCP: If Instance Creator UID corresponds to a version of ALA, then it is used to prevent loading of old-format RT Structure Sets, otherwise not used.
SOP Instance Status	(0100,0410)	3	SCU: Always set to AO SCP: Not used.
SOP Authorization date and time	(0100,0420)	3	SCU: Date and time when the object is saved SCP: Not used.
SOP Authorization Comment	(0100,0424)	3	SCU: XML format, define patient follow up strategy, next date, Examination information… SCP: Not used.

2.6 PRIVATE DATA DICTIONARY FOR RT STRUCTURE SET

There are no private elements at this time.

Private Creator Identification GEMS_RTEN_01

Attribute Name	Element Tag	VR	VM