

Limbus Contour

DICOM Conformance Statement

Purpose

This document provides information about the DICOM Conformance of Limbus Contour version 1.7.

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Support

Contact support@limbus.ai for information on this document.

Website: www.limbus.ai

Document History

| | | |
|---|-------------------|--|
| 1 | March 27, 2020 | Initial version for Limbus Contour 1.1.0 |
| 2 | December 19, 2020 | Changes for Limbus Contour release 1.3.0. StructureSetLabel now configurable. |
| 3 | August 4, 2023 | Updated product version - removed manufacturer address as its available through other channels |

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1 Introduction

1.1 Intended Readers

The reader of this document is concerned with software design and/or system integration with Limbus Contour. It is assumed that readers are familiar with the DICOM standard.

This document is based on the template definition in the DICOM standard (PS3.2).

1.2 Remarks

The scope of this DICOM Conformance Statement is to facilitate integration between Limbus Contour and other DICOM products. The Conformance Statement should be read and understood in conjunction with the DICOM Standard. DICOM by itself does not guarantee interoperability. The Conformance Statement does, however, facilitate a first-level comparison for interoperability between different applications supporting compatible DICOM functionality.

This Conformance Statement is not supposed to replace validation with other DICOM equipment to ensure proper exchange of intended information. In fact, the user should be aware of the following important issues:

- The comparison of different Conformance Statements is just the first step towards assessing the interconnectivity and interoperability between the product and other DICOM conformant equipment.
- Test procedures should be defined and executed to validate the required level of interoperability with specific compatible DICOM equipment, as established by the healthcare facility.

1.3 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 |
| CT | Computed Tomography |

| | |
|-------|---|
| DICOM | Digital Imaging and Communication In Medicine |
| FSC | File-Set Creator |
| FSR | File-Set Reader |
| FSU | File-Set Updater |
| GUI | Graphical User Interface |
| IOD | DICOM Information Object Definition |
| MR | Magnetic Resonance |
| ROI | Region-of-Interest |
| RT | Radiotherapy |
| SOP | DICOM Service-Object Pair |
| UID | Unique Identifier |

1.4 References

NEMA PS3 / ISO 12052, Digital Imaging and Communications in Medicine (DICOM) Standard, National Electrical Manufacturers Association, Rosslyn, VA, USA (available free at <http://medical.nema.org/>)

1.5 Overview

Limbus Contour is a stand-alone, installable-executable, and single-purpose software application intended for use by trained radiation oncologists, dosimetrists, and medical physicists to derive optimal organ and clinical target volume contours for input to radiation treatment planning.

The core purpose of Limbus Contour is to perform automatic segmentation (contouring) of regions-of-interest (ROIs/structures) of user-imported computed tomography (CT) and magnetic resonance (MR) DICOM images and to export corresponding segmentations to DICOM RT-Structure Set files. Limbus Contour is controlled via a Graphical User Interface (GUI).

Limbus Contour also supports creation of placeholder structures. These are structures written to DICOM RT-Structure Sets that contain no contour data (user populates contour data manually after RT-Structure Set export).

Limbus Contour does not support any of the DICOM networking services (transfer, query/retrieve, workflow management, print management). Instead, a user interface is provided to import DICOM image files and export DICOM RT-Structure Set files.

This conformance statement will cover only conformance to the DICOM Structure Set IOD.

Limbus Contour can read/import the following IODs:

| SOP Class Name | SOP Class UID |
|---------------------------|------------------|
| 1.2.840.10008.5.1.4.1.1.2 | CT Image Storage |
| 1.2.840.10008.5.1.4.1.1.4 | MR Image Storage |

Table 1 – Supported IODs for read

| Transfer Syntax | Transfer Syntax UID |
|---------------------------|---------------------|
| Implicit VR Little Endian | 1.2.840.10008.1.2 |
| Explicit VR Little Endian | 1.2.840.10008.1.2.1 |
| Explicit VR Big Endian | 1.2.840.10008.1.2.2 |

Table 2 – IMPORT-FSR IOD Transfer Syntax

Limbus Contour can write/export the following IODs:

| SOP Class Name | SOP Class UID |
|-------------------------------|---|
| 1.2.840.10008.5.1.4.1.1.481.3 | Radiation Therapy Structure Set Storage |

Table 3 - Supported IODs for write

| Transfer Syntax | Transfer Syntax UID |
|---------------------------|---------------------|
| Implicit VR Little Endian | 1.2.840.10008.1.2 |

Table 4 – EXPORT-FSC IOD Transfer Syntax

2 Networking

Limbus Contour does not provide any DICOM networking services or support any networking roles.

3 Media Interchange

Limbus Contour does not provide any media interchange services.

4 Transformation of DICOM to CDA

Limbus Contour does not support any Structured Reporting (SR) objects.

5 Support of Character Sets

5.1 Decoding

Limbus Contour supports decoding of the following character sets:

| Character Set | Defined Term |
|----------------------|--------------|
| Default repertoire | ISO IR 6 |
| Latin alphabet No. 1 | ISO IR 100 |
| Latin alphabet No. 2 | ISO IR 101 |
| Latin alphabet No. 3 | ISO IR 109 |
| Latin alphabet No. 4 | ISO IR 110 |
| Greek | ISO IR 126 |
| Arabic | ISO IR 127 |
| Hebrew | ISO IR 138 |
| Cyrillic | ISO IR 144 |
| Latin alphabet No. 5 | ISO IR 148 |
| Thai | ISO IR 166 |
| Unicode in UTF-8 | ISO IR 192 |

Table 5 - Character sets supported for decoding from DICOM

The Specific Character Set value is read from the DICOM tag field 0008,0005.

When an unsupported character is received it shall be tried and decoded according the default repertoire. Otherwise unsupported characters shall be displayed as "?". Usage of non-latin characters should be validated carefully.

5.2 Encoding

The default character set used for encoding is ISO_IR 100, otherwise the exported DICOM RT Structure Set objects will have the same Specific Character set as the referring DICOM images.

6 Security

Limbus Contour does not support any specific DICOM security measures. It is assumed that Limbus Contour is used within a secured environment.

7 Annexes

7.1 IOD Contents

7.1.1 Usage of Attributes from Received IODs

The following table applies to read/import of the following IODs:

| SOP Class Name | SOP Class UID |
|---------------------------|------------------|
| 1.2.840.10008.5.1.4.1.1.2 | CT Image Storage |
| 1.2.840.10008.5.1.4.1.1.4 | MR Image Storage |

Table 6 - Supported IODs for read

A description of attributes read from received UID and their usage is provided in the following table:

| Attribute Name | Tag | Usage/Comment |
|----------------------------|-----------|----------------|
| Patient's Name | 0010,0010 | Identification |
| Patient ID | 0010,0020 | Identification |
| Patient's Sex | 0010,0040 | Identification |
| Patient's Birth Date | 0010,0030 | Identification |
| Patient's Age | 0010,1010 | Identification |
| Study Instance UID | 0020,000D | Identification |
| Study ID | 0020,0010 | Identification |
| Study Date | 0008,0020 | Identification |
| Study Time | 0008,0030 | Identification |
| Referring Physician's Name | 0008,0090 | Identification |
| Accession Number | 0008,0050 | Identification |

| | | |
|------------------------|-----------|--|
| Modality | 0008,0060 | Identification/Validation (CT and MR are supported) |
| Series Instance UID | 0020,000E | Identification / organization of images in several series |
| Series Description | 0008,103E | Identification |
| SOP Class UID | 0008,0016 | Verification, the application supports the following SOPs: 1.2.840.10008.5.1.4.1.1.2 1.2.840.10008.5.1.4.1.1.4 |
| SOP Instance UID | 0008,0018 | Image object identification |
| Specific Character Set | 0008,0005 | The exported DICOM RT Structure Set objects will have the same Specific Character set as the referring DICOM images |
| Frame of Reference UID | 0020,0052 | Frame of Reference to other DICOM objects |
| Rescale Slope | 0028,1053 | Pixel data interpretation / reconstruction of images for segmentation |
| Rescale Intercept | 0028,1052 | Pixel data interpretation / reconstruction of images for segmentation |
| Window Center | 0028,1050 | Pixel data interpretation / reconstruction of images for segmentation |
| Window Width | 0028,1051 | Pixel data interpretation / reconstruction of images for segmentation |
| Pixel Spacing | 0028,0030 | Reconstruction of images for segmentation |

| | | |
|---------------------------|-----------|---|
| Image Position (Patient) | 0020,0032 | Reconstruction of images for segmentation |
| Image Orientation Patient | 0027,0037 | Reconstruction of images for segmentation. Only [1, 0, 0, 0, 1, 0] orientation is supported. |
| Slice Thickness | 0018,0050 | Identification |
| Pixel Data | 7FE0,0000 | Pixel data interpretation / reconstruction of images for segmentation |
| Transfer Syntax UID | 0002,0010 | Criteria to perform byte swapping |

Table 7 - Usage of Attributes for read IODs

7.1.1.1 Required Attributes

Images will not be imported (indicated by error messages) if they don't contain valid representations for the following tags (these tags are required for construction of RT-Structure Sets):

| Name | Tag |
|---------------------------|-----------|
| Pixel Data | 7FE0,0000 |
| SOP Class UID | 0008,0016 |
| SOP Instance UID | 0008,0018 |
| Pixel Spacing | 0028,0030 |
| Image Position Patient | 0020,0032 |
| Image Orientation Patient | 0020,0037 |
| Frame of Reference UID | 0020,0052 |
| Study Instance UID | 0020,000D |
| Series Instance UID | 0020,000E |
| Modality | 0008,0060 |

Table 8 - Required Attributes for read IODs

7.1.2 Created SOP Instances

IODs created by Limbus Contour are listed below along with supported modules and mapping between Attributes where applicable.

| SOP Class Name | SOP Class UID |
|--------------------------------|-------------------------------|
| RT Structure Set Storage Class | 1.2.840.10008.5.1.4.1.1.481.3 |

Table 9 - List of created SOP Classes

7.1.2.1 RT Structure Set Information Object Implementation

| IE | Module | PS 3.3 Reference | Support |
|--------------------|---------------------------|------------------|---------------|
| Patient | Patient | C.7.1.1 | |
| | Clinical Trial Subject | C.7.1.3 | Not Supported |
| Study | General Study | C.7.2.1 | |
| | Patient Study | C.7.2.2 | |
| | Clinical Trial Study | C.7.2.3 | Not Supported |
| Series | RT Series | C.8.8.1 | |
| Frame of Reference | Frame of Reference | C.7.4.1 | Not Supported |
| Equipment | General Equipment | C.7.5.1 | |
| Structure Set | Structure Set | C.8.8.5 | |
| | ROI Contour | C.8.8.6 | |
| | RT ROI Observations | C.8.8.8 | |
| | Approval | C.8.8.16 | |
| | Common Instance Reference | C.12.2 | Not Supported |
| | SOP Common | C.12.1 | |

Table 10 - RT Structure Set IOD Modules Support

7.1.2.2 Modules and Attributes

This section specifies the IOD created by this application (RT-Structure Set only) and specifies the content of each IOD. For each attribute in the IOD the following information is provided:

- Attribute Name
- Tag

- VR (Value Representation)
- Value (Possible values)
- Presence (of Value)
- Source

The following tables use a number of abbreviations. The abbreviations used in the “Presence” column are:

- **VNAP** – Value Not Always Present (attribute saved with zero length if no value is present)
- **ANAP** – Attribute Not Always Present
- **ALWAYS** – Always Present
- **EMPTY** – Attribute is sent without a value
- **N/A** – Attribute does not have a value, e.g., a sequence (SQ)

The abbreviations used in the “Source” column are:

- **USER** – the attribute value source is from User input
- **AUTO** – the attribute value is generated automatically

| PATIENT MODULE ATTRIBUTES | | | | | |
|---------------------------|-----------|----|--------|----------|---|
| Attribute Name | Tag | VR | Value | Presence | Source |
| Patient's Name | 0010,0010 | PN | Copied | VNAP | Patient's Name from referenced image series associated with the structure set |
| Patient ID | 0010,0020 | LO | Copied | VNAP | Patient ID from referenced image series associated with the structure set |
| Patient's Birth Date | 0010,0030 | DA | Copied | VNAP | Patient's Name from referenced image series associated with the structure set |
| Patient's Sex | 0010,0040 | CS | Copied | VNAP | Patient's Sex from referenced image series associated with the structure set |

Table 11 - Patient Module Attributes

| PATIENT STUDY MODULE ATTRIBUTES | | | | | |
|---------------------------------|-----|----|-------|----------|--------|
| Attribute Name | Tag | VR | Value | Presence | Source |

| | | | | | |
|---------------|-----------|----|--------|------|--|
| Patient's Age | 0010,1010 | AS | Copied | VNAP | Patient's Age from referenced image series associated with the structure set |
|---------------|-----------|----|--------|------|--|

Table 12 - Patient Study Module Attributes

| GENERAL STUDY MODULE ATTRIBUTES | | | | | |
|---------------------------------|-----------|----|--------|----------|---|
| Attribute Name | Tag | VR | Value | Presence | Source |
| Study Instance UID | 0020,000D | UI | Copied | ALWAYS | Study Instance UID from referenced images associated with the structure set |
| Study Date | 0008,0020 | DA | Copied | VNAP | Study Date from referenced images associated with the structure set |
| Study Time | 0008,0030 | DA | Copied | VNAP | Study Time from referenced images associated with the structure set |
| Referring Physician's Name | 0008,0090 | PN | Copied | VNAP | Referring Physician's Name from referenced images associated with the structure set |
| Study ID | 0020,0010 | SH | Copied | VNAP | Study ID from referenced images associated with the structure set |
| Accession Number | 0008,0050 | SH | Copied | VNAP | Accession Number from referenced images associated with the structure set |
| Study Description | 0008,1030 | LO | Copied | ANAP | Study Description from referenced images associated with the structure set |

Table 13 - General Study Module Attributes

| RT SERIES MODULE ATTRIBUTES | | | | | |
|-----------------------------|-----------|----|---------------|----------|-------------------|
| Attribute Name | Tag | VR | Value | Presence | Source |
| Modality | 0008,1080 | CS | "RTSTRUCT" | ALWAYS | Set to 'RTSTRUCT' |
| Series Instance UID | 0020,000E | UI | Generated UID | ALWAYS | AUTO |

| | | | | | |
|-----------------|------------|----|--------|-------|--|
| Series Number | 0020,0011 | IS | | EMPTY | AUTO |
| Operator's Name | 0008, 1070 | PN | Copied | ANAP | Operator's Name from referenced images associated with the structure set |

Table 14 - RT Series Module Attributes

| GENERAL EQUIPMENT MODULE ATTRIBUTES | | | | | |
|-------------------------------------|-----------|----|-------------------------------|----------|--------|
| Attribute Name | Tag | VR | Value | Presence | Source |
| Manufacturer | 0008,0070 | LO | "Limbus AI Inc." | ALWAYS | AUTO |
| Manufacturer's Model Name | 0008,1090 | LO | "Limbus Contour" | ALWAYS | AUTO |
| Software Versions | 0018,1020 | LO | Limbus Contour version number | ALWAYS | AUTO |

Table 15 - General Equipment Module Attributes

| STRUCTURE SET MODULE ATTRIBUTES | | | | | |
|---------------------------------|-----------|----|-----------------------------------|----------|---|
| Attribute Name | Tag | VR | Value | Presence | Source |
| Structure Set Label | 3006,0002 | SH | Default: "Limbus RTStruct" | ALWAYS | AUTO |
| Structure Set Name | 3006,0004 | LO | Copied | VNAP | Configurable within application Series Description of image series associated with the structure set |
| Structure Set Description | 3006,0006 | ST | "Limbus Contour" | ALWAYS | AUTO |
| Instance Number | 0020,0013 | IS | | EMPTY | |
| Structure Set Date | 3006,0008 | DA | Date RT Structure Set was created | ALWAYS | AUTO |

| | | | | | |
|---------------------------------------|-----------|----|--|--------|--|
| Structure Set Time | 3006,0009 | TM | Time RT Structure Set was created | ALWAYS | AUTO |
| Reference Frame of Reference Sequence | 3006,0010 | SQ | Only one item in this sequence is supported | N/A | |
| >Frame of Reference UID | 0020,0052 | UI | Copied | ALWAYS | Frame of Reference UID of image series associated with the structure set |
| >RT Referenced Study Sequence | 3006,0012 | SQ | Only one item in this sequence is supported. | N/A | Generated from images used to create the structure set. |
| >>Referenced SOP Class UID | 0008,1150 | UI | Copied | ALWAYS | SOP Class UID of image series associated with the structure set |
| >>Referenced SOP Instance UID | 0008,1155 | UI | Copied | ALWAYS | Study Instance UID of image study associated with the structure set |
| >>RT Referenced Series Sequence | 3006,0014 | SQ | Only one item in this sequence is supported. | N/A | Generated from images used to create the structure set. |
| >>>Series Instance UID | 0020,000E | UI | Copied | ALWAYS | Series Instance UID of image series associated with the structure set |
| >>>Contour Image Sequence | 3006,0016 | SQ | | N/A | One item per image in the series |
| >>>>Referenced SOP Class | 0008,1150 | UI | Copied | ALWAYS | SOP Class UID of referenced image series associated with the structure set |

| | | | | | |
|------------------------------------|-----------|----|--|--------|--|
| >>>>Referenced SOP Instance UID | 0008,1155 | UI | Copied | ALWAYS | SOP Instance UID of referenced image |
| Structure Set ROI Sequence | 3006,0020 | SQ | | N/A | One item per structure |
| >ROI Number | 3006,0020 | IS | Uniquely generated (sequence starting at 1) ROI numbers are organized based on ROI Name (alphabetically) | ALWAYS | AUTO |
| >Referenced Frame of Reference UID | 3006,0024 | UI | Copied | ALWAYS | Frame of Reference UID of image series associated with the structure set |
| >ROI Name | 3006,0026 | LO | User defined ROI Name | ALWAYS | USER |
| >ROI Generation Algorithm | 3006,0036 | CS | “AUTOMATIC” for automatically segmented structures “MANUAL” for Empty Structures (placeholders) | ALWAYS | AUTO |
| >ROI Generation Description | 3006,0038 | LO | “Limbus Contour Machine Learning Auto-segmentation” for automatically segmented structures. EMPTY for Empty Structures (placeholders) | VNAP | AUTO |

Table 16 - Structure Set Module Attributes

| ROI CONTOUR MODULE ATTRIBUTES | | | | | |
|-------------------------------|-----|----|-------|----------|--------|
| Attribute Name | Tag | VR | Value | Presence | Source |

| | | | | | |
|--------------------------------|-----------|----|--|--------|---|
| ROI Contour Sequence | 3006,0039 | SQ | | N/A | One item per structure |
| >Referenced ROI Number | 3006,0084 | IS | Reference to structure ROI Number | ALWAYS | AUTO |
| >ROI Display Color | 3006,002A | IS | User defined structure color | ALWAYS | USER |
| >Contour Sequence | 3006,0040 | SQ | | N/A | One item per region in structure This sequence is EMPTY for Empty Structures (placeholders). |
| >>Contour Image Sequence | 3006,0016 | SQ | | N/A | Only one item in this sequence is supported. |
| >>>Referenced SOP Class UID | 0008,1150 | UI | Copied | ALWAYS | SOP Class UID of referenced image series associated with the structure set |
| >>>Referenced SOP Instance UID | 0008,1155 | UI | Copied | ALWAYS | SOP Instance UID of referenced image |
| >>Contour Geometric Type | 3006,0042 | CS | "CLOSED_PLANAR" | ALWAYS | |
| >>Number of Contour Points | 3006,0046 | IS | Number of vertices in the structure. | ALWAYS | AUTO |
| >>Contour Data | 3006,0050 | DS | Vertex coordinates of structure in DICOM patient coordinate system | ALWAYS | AUTO |

Table 17 - ROI Contour Module Attributes

| RT ROI OBSERVATIONS MODULE ATTRIBUTES | | | | | |
|---------------------------------------|-----|----|-------|----------|--------|
| Attribute Name | Tag | VR | Value | Presence | Source |

| | | | | | |
|--|-----------|----|--|-----------------------|-------------|
| RT ROI Observations Sequence | 3006,0080 | SQ | One item per structure | N/A | |
| >Observation Number | 3006,0082 | IS | Index starting at 0 | ALWAYS | AUTO |
| >Referenced ROI Number | 3006,0084 | IS | Reference to structure ROI Number | ALWAYS | AUTO |
| >>RT ROI Identification Code Sequence | 3006,0086 | SQ | Only one item is supported | USER enabled/disabled | |
| >>Include Table 8.8-1 "Code Sequence Macro Attributes" | | | | | |
| >>Code Value | 0008,0100 | SH | User defined Code Value for structure | ANAP | USER |
| >>Coding Scheme Designator | 0008,0102 | SH | User defined Coding Scheme Designator for structure | ANAP | USER |
| >>Code Meaning | 0008,0104 | LO | User defined Code Meaning for structure | ANAP | USER |
| >>Context Identifier | 0008,010F | CS | User defined Context Identifier | ANAP | USER |
| >>Mapping Resource | 0008,0105 | CS | User defined Mapping Resource | ANAP | USER |
| >>Context Group Version | 0008,0106 | DT | User defined Context Group Version | ANAP | USER |
| >RT ROI Interpreted Type | 3006,00A4 | CS | Defined for each automatically segmented structure. User defined value for empty structures (placeholders). | ALWAYS | AUTO / USER |

| | | | | | |
|------------------|-----------|----|--|-------|------|
| >ROI Interpreter | 3006,00A6 | PN | | EMPTY | AUTO |
|------------------|-----------|----|--|-------|------|

Table 18 - RT ROI Observations Module Attributes

| APPROVAL MODULE ATTRIBUTES | | | | | |
|----------------------------|-----------|----|--------------|----------|--------|
| Attribute Name | Tag | VR | Value | Presence | Source |
| Approval Status | 300E,0002 | CS | "UNAPPROVED" | ALWAYS | AUTO |

Table 19 - Approval Module Attributes

| SOP COMMON MODULE ATTRIBUTES | | | | | |
|------------------------------|-----------|----|-----------------------------------|----------|---|
| Attribute Name | Tag | VR | Value | Presence | Source |
| SOP Class UID | 0008,0016 | UI | "1.2.840.10008.5.1.4.1.1.481.3" | ALWAYS | AUTO |
| | | | Radiotherapy Structure Set UID | | |
| SOP Instance UID | 0008,0018 | UI | Generated UID | ALWAYS | AUTO |
| Specific Character Set | 0008,0005 | CS | Copied | ALWAYS | Specific Character Set from referenced images associated with the structure set |
| Instance Creation Date | 0008,0012 | DA | Date RT Structure Set was created | ALWAYS | AUTO |
| Instance Creation Time | 0008,0013 | TM | Time RT Structure Set was created | ALWAYS | AUTO |

Table 20 - SOP Common Module Attributes

7.1.2.3 Attribute Mapping

No Attribute Mapping is performed.

7.1.2.4 Coerced/Modified Fields

No fields are coerced or modified.

7.2 Data Dictionary of Private Attributes

No Private Attributes are defined.

7.3 Coded Terminology and Templates

Not supported.

7.4 Private Transfer Syntaxes

No Private Transfer Syntaxes are supported.