Rady Children's Hospital-San Diego

Media2DICOM

A media conversion and encapsulation tool developed by the Helen and Will Webster Foundation 3D Innovation's Lab

The document is intended to cover version 0.9.3.

4-28-2025

1 Table of Contents

2 Introduction

2.1 Revision History

This sections documents changes in the software.

Version	Comments
0.9.3	- Improved DICOM Conformance: - Added Position Reference Indicator (0020, 1040). - Added Measurement Units Code sequence (0040, 08EA) to encapsulated STLs. - Added Referenced Series Sequence (0008, 1115). - Updated Character Set (0008, 0005) to "Unicode in UTF-8" (ISO_IR 192). - Updated Referenced Study Sequence (0008, 1110) to be copied from source DICOM if the attribute is present. - Fixed transfer syntax for STLs to correctly use Implicit VR Little Endian. - Removed Referenced Patient Sequence (0008, 1120). - Other changes: - Fixed crash which could occur when clearing the cache folder.
0.9.2	- Added a version checker. If a new version of Media2DICOM is available, a button will appear that launches the Media2DICOM website to download the latest installer. - Updated method for sampling frames from videos. Media2DICOM will now generate images based on the sample interval defined by the user over the entire duration of the video. - Updated ASCII to binary conversion process for STL files to improve compatibility. - Fixed conversion of model color values (RGB to CIE Lab to Unsigned Short) during encapsulation process.
0.9.1	- FO-DICOM (version 4.0.6) previously used PDF SOP Class (1.2.840.10008.5.1.4.1.1.104.1) for encapsulation of STLs. Media2DICOM now exports appropriate SOP Class (1.2.840.10008.5.1.4.1.1.104.3). - FO-DICOM library updated to latest version (version 4.0.8). - Media2DICOM now copies Referenced SOP Class UID (0008,1150) and Referenced SOP Instance UID (0008,1155) from source DICOM to encapsulated media. - Media2DICOM now uses UI Frame of Reference UID (0020,0052) from source DICOM. - Users can now overwrite the Accession Number (0008,0050) at export; default number will be copied from source DICOM. - Users can toggle adding color information to LO Content Description (0070,0081); color will still be added to US Recommended Display CIELab Value (00662,000d) regardless of toggled field.
0.9.0	Initial Release

2.2 Audience

This document is intended for the audience listed below. It is assumed that the reader has a working knowledge of the DICOM Standard.

The document structure was designed for easier access to relevant information for different user groups:

- Clinical Users
- System Integrators
- Hospital IT staff
- Research Personnel

2.3 Remarks

The scope of this DICOM Conformance Statement is to facilitate integration between Media2DICOM and other DICOM products. The Conformance Statement should be read and understood in conjunction with the DICOM Standard [1]. 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 should not replace validation with other DICOM equipment to ensure proper exchange of intended information. In fact, it is the user's responsibility to perform the following validation activities:
- The comparison of Conformance Statements from Media2DICOM and other DICOM conformant equipment is the first step towards assessing interconnectivity and interoperability between those systems.
- Test procedures should be defined and executed to validate the required level of interoperability with specific DICOM conformant equipment, as established by the healthcare facility.

2.4 Terms and Definitions

The following list includes DICOM Terms, that are used throughout this conformance statement:

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)   A representation of the external behavior of an application process in terms of DICOM network services, Web services and/or media exchange capabilities implemented in one or more roles. A single device may have multiple Application Entities.

Application Entity Title (AET)   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. Examples: MR Image IOD, CT Image IOD, Print Job IOD. The Attributes within an IOD 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).
Media Application Profile	The specification of DICOM information objects and encoding exchanged on removable media (e.g., CDs).
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.
Origin Server	Refers to the program that can originate authoritative responses to HTTP requests for a given target resource. The term "server" refers to any implementation that receives a web service request message from a user agent.
Presentation Context	The set of DICOM network services used over an Association, as negotiated between Application Entities; includes Abstract Syntaxes and Transfer Syntaxes.
Private SOP Class	A SOP Class that is not defined in the DICOM Standard but is published in an implementation's Conformance Statement.
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 Class (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 Instance (SOP Instance)	An information object; a specific occurrence of information exchanged in a SOP Class. E.g., a specific X-ray image.
Specialized SOP Class	A SOP class that is derived from the Standard that is specialized by additional type 1, 1C, 2, 2C, or 3 attributes by enumeration of specific permitted values for Attributes, or by enumeration of specific permitted Templates. The additional Attributes may either be drawn from the Data Dictionary in PS3.6 or may be Private Attributes.
Standard SOP Class	A SOP class defined in the Standard, and that is implemented and used without any modifications.
Standard Extended SOP Class	A SOP class that is defined in the standard, and that is extended by additional type 3 attributes. The additional Attributes may either be drawn from the DICOM Data Dictionary in PS3.6 or may be Private Attributes.
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: JPEG compressed (images), Little Endian Explicit Value Representation.
TLS-Secured Port	TCP port on which an implementation accepts TLS connections to exchange DICOM information
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.
User Agent	A client in a network protocol used in communications within a client–server distributed computing system. In particular, the Hypertext Transfer Protocol (HTTP) identifies the client software originating the request, using a user-agent header, even when the client is not operated by a user
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.

The following list includes product specific definitions used throughout this Conformance Statement:

Product-specific Term	*This is a product specific term used throughout this Conformance Statement*

Bitmap (BMP)	A common image file format.
JPEG	A common image file format.
STL	A common 3D file format, often intended for 3D printing.
PNG	A common image file format.
MP4	A common video file format.

2.5 Abbreviations

Abbreviations that are used in this DICOM Conformance Statement are listed here.

AE	Application Entity
AET	Application Entity Title
BMP	Bitmap
CAD	Computer Aided Detection
CDA	Clinical Document Architecture
CID	Context Identifier
DCS	DICOM Conformance Statement
DHCP	Dynamic Host Configuration Protocol
DICOM	Digital Imaging and Communications in Medicine
ELE	Explicit VR Little Endian
FSC	File-Set Creator
FSU	File-Set Updater
FSR	File-Set Reader
IANA	Internet Assigned Numbers Authority
IHE	Integrating the Healthcare Enterprise
ILE	Implicit VR Little Endian
IOD	Information Object Definition
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISO	International Organization for Standardization
JPEG	[File format by the] Joint Photographic Experts Group
MP4	MPEG-4 Part 14 (Moving Picture Experts Group)
MPPS	Modality Performed Procedure Step
MWL	Modality Worklist
NEMA	National Electrical Manufacturers Association
NTP	Network Time Protocol
OID	Object Identifier
OS	Origin Server
PDU	Protocol Data Unit
PHI	Protected Health Information
PNG	Portable Network Graphics
PPS	Performed Procedure Step
QIDO-RS	Query based on ID for DICOM Objects by RESTful Services
RTV	Real Time Video
SCP	Service Class Provider
SCU	Service Class User
SOP	Service-Object Pair
SPS	Scheduled Procedure Step

SR	Structured Reporting
STL	Stereolithographic Language (also Standard Tessellation Language)
STOW-RS	STore Over the Web by RESTful Services
TCP/IP	Transmission Control Protocol/Internet Protocol
TID	Template Identifier
UA	User Agent
UI	User Interface
UID	Unique Identifier
UL	Upper Layer
UPS	Unified Procedure Step
UPS-RS	Unified Procedure Step by RESTful Services
VR	Value Representation
WADO-RS	Web Access to DICOM Objects by RESTful Services
WADO-URI	Web Access to DICOM Objects by URI

2.6 References

1. NEMA PS3 Digital Imaging and Communications in Medicine (DICOM) Standard, available free at http://www.dicomstandard.org/current

3 Implementation Module

3.1 Application Entities and Data Flow

The network and media interchange application model for the Media2DICOM is shown in Figure A.4 1: Media2DICOM Application Data Flow Diagram.

Media2DICOM is a standalone component which enables a user to query using C-MOVE and retrieve DICOM metadata from a connected PACS system. The user can then build new DICOM files with various media payloads (images, videos [discretized into frames], and 3D files) with appropriate, already queried metadata. The user can send the resulting DICOM files back to PACS using C-STORE.

Media2DICOM is installed onto a client Windows machine. When servers are added to Media2DICOM, the information is validated using C-ECHO. A more complete data flow will be available in the next revision of this document.
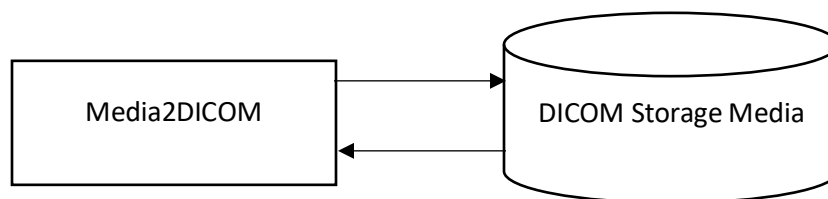
4 Configuration

Throughout all subsection the following values can be used in the "Configurable" column:

- • USER: The parameter is configurable by the user
- • FIXED: The parameter is not configurable (it has a fixed value).

4.1 General Configuration Parameters

Table A.6 lists general configuration parameters.

Parameter	Configurable	Default Value	Comments
Cache Directory	*USER*	%AppData%	Directory where cached files, including DICOMs, are stored during the conversion process.
Upload size warning	*USER*	256 MB	User receives warning if generated DICOM exceeds set value
Upload limit	*FIXED*	4000 MB	Maximum size of a DICOM permitted to be sent to a remote server.

4.2 Configuration of Media2DICOM Services

The Tables in the following subsections show the configuration parameters required for Media2DICOM.

Client Configuration Parameters			
Parameter	**Configurable**	**Default Value**	**Comments**
AE Title	*USER*		
Port	*USER*		
Server Configuration Parameters			
Parameter	**Configurable**	**Default Value**	**Comments**
IP Address	*USER*		
Port	*USER*		
AE Title	*USER*		
Description	*USER*		*Information is only relevant to the user.*

5 Media Storage AE

Media2DICOM provides Standard Conformance to the following Storage SOP Classes.

SOP Class Name	UID
CR Image Storage	1.2.840.10008.5.1.4.1.1.1
Digital X-Ray Image Storage – for Presentation	1.2.840.10008.5.1.4.1.1.1.1
Digital X-Ray Image Storage – for Processing	1.2.840.10008.5.1.4.1.1.1.1.1
Digital Mammography X-Ray Image Storage – for Presentation	1.2.840.10008.5.1.4.1.1.1.2
Digital Mammography X-Ray Image Storage – for Processing	1.2.840.10008.5.1.4.1.1.1.2.1
Digital Intra – oral X-Ray Image Storage – for Presentation	1.2.840.10008.5.1.4.1.1.1.3
Digital Intra – oral X-Ray Image Storage – for Processing	1.2.840.10008.5.1.4.1.1.1.3.1

Encapsulated PDF Storage	1.2.840.10008.5.1.4.1.1.104.1
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1
Color Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.2
Pseudocolor Softcopy Presentation Stage Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.3
Blending Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.4
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1
Enhanced XA Image Storage	1.2.840.10008.5.1.4.1.1.12.1.1
X-Ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2
Enhanced XRF Image Storage	1.2.840.10008.5.1.4.1.1.12.2.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1
NM Image Storage	1.2.840.10008.5.1.4.1.1.20
Ultrasound Multiframe Image Storage	1.2.840.10008.5.1.4.1.1.3
Ultrasound Multiframe Image Storage	1.2.840.10008.5.1.4.1.1.3.1
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1
MR Spectroscopy Storage	1.2.840.10008.5.1.4.1.1.4.2

When sending images and discretized video (commonly referred to as "cine") back to PACS via C-STORE, Media2DICOM will export/store in the same modality as the source DICOM. The choice to keep the modality is a pragmatic one to prevent unnecessary billing events. Future revisions will enable users to select modality.

In addition, it will store the images with the same study date and time. The following transfer syntaxes are implemented.

SOP Class Name	UID
JPEG Baseline (Process 1)	1.2.840.10008.1.2.4.50
JPEG Lossless, Non-Hierarchical, First-Order Prediction	1.2.840.10008.1.2.4.70
JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
JPEG Extended (Process 2 & 4)	1.2.840.10008.1.2.4.51

When sending 3D datasets (encapsulated STL) to PACS, the modality will be M3D. The resulting SOP class will be the following:

SOP Class Name	UID
Encapsulated STL Storage	1.2.840.10008.5.1.4.1.1.104.3

ASCII STL models are converted to Binary STL before encapsulation.

The following SOP Classes are permitted for M3D export/store.

SOP Class Name	UID
Explicit VR Little Endian	1.2.840.10008.1.2.1

6 Information Object Definitions

Table A.85.1-1 specifies the Encapsulated STL IOD Modules.

Table A.85.1-1. Encapsulated STL 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	Encapsulated Document Series	C.24.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Encapsulated Document	Encapsulated Document	C.24.2	M
	Manufacturing 3D Model	C.35.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Source Instance Sequence	C.12.2	C - Required if other Instances are referenced

6.1 Attributes for Manufacturing 3D Model

Media2DICOM enables a user to control the following attributes for encapsulated STLs.

Attribute Name	Tag	Type	Attribute Description
Model Group UID	(0068,7004)	3	Uniquely identifies a group to which the model belongs. Manufacturing models that share the same Model Group UID are considered distinct parts within the same assembly.
Recommended Display CIELab Value	(0062,000D)	3	Specifies the color recommended to be used for the model. This color applies both when digitally displaying the model and when selecting material for manufacturing. This would typically be used to visually distinguish between models that are part of the same assembly and/or provide best analog to real world appearance. The units are specified in PCS-Values, and the value is encoded as CIELab.
Recommended Presentation Opacity	(0066,000C)	3	Specifies the opacity recommended to be used for the model. This opacity applies both when digitally displaying the model and when selecting material for manufacturing.

			A non-opaque value would typically be specified when either (a) another model grouped in the same assembly needs to be visible behind or inside this model, or (b) the model represents anatomy that is not fully opaque. If not present, then it is assumed the model should be presented and manufactured as opaque.
Content Description	(0070,0081)	3	The model's assigned color value is stored in this field as "ColorRGB(R, G, B)".