Digital Imaging and Communications in Medicine (DICOM)

Supplement 18

Media Storage Application Profiles

for CT and MR Images

Status: Final Text, Sep 25th, 1997

Table of Contents

Table of Contents i
Annex X (Normative) - CT and MR Image Application Profiles 2
X.1 PROFILE IDENTIFICATION 2
X.2 CLINICAL CONTEXT 2
X.2.1 Roles and Service Class Options 2
X.3 STD-CTMR PROFILES 3
X.3.1 SOP Classes and Transfer Syntaxes 3
X.3.2 Physical Medium And Medium Format 5
X.3.3 Directory Information in DICOMDIR 5
X.3.4 Other Parameters 5

Digital Imaging and Communications in Medicine (DICOM)

PART 11 Addendum:

CT and MR Application Profiles

Annex X (Normative) - CT and MR Image Application Profiles

X.1 PROFILE IDENTIFICATION

This Annex defines Application Profiles for Computed Tomography and Magnetic Resonance Imaging interchange and storage on high capacity rewriteable magneto-optical disks (MOD) and CD-R with lossless compression.

Table X.1 - STD-CTMR Profiles

Application Profile	Identifier	Description
CT/MR Studies on 650MB MOD	STD-CTMR-MOD650	Handles single frame 8, 12 or 16 bit grayscale and 8 bit palette color, uncompressed and lossless compressed images.
CT/MR Studies on 1.2GB MOD	STD-CTMR-MOD12	Handles single frame 8, 12 or 16 bit grayscale and 8 bit palette color, uncompressed and lossless compressed images.
CT/MR Studies on 2.3GB MOD	STD-CTMR-MOD23	Handles single frame 8, 12 or 16 bit grayscale and 8 bit palette color, uncompressed and lossless compressed images.
CT/MR Studies on CD-R	STD-CTMR-CD	Handles single frame 8, 12 or 16 bit grayscale and 8 bit palette color, uncompressed and lossless compressed images.

X.2 CLINICAL CONTEXT

These Application Profiles facilitate the interchange and storage of primary CT and MR images as well as related Secondary Capture Images with certain defined attributes, including grayscale and palette color images. CT, MR and SC images may co-exist within the same File-set.

Typical interchanges would be between acquisition devices, archives and workstations, within and between institutions.

X.2.1 Roles and Service Class Options

These Application Profiles uses the Media Storage Service Class defined in PS 3.4 with the Interchange Option.

The Application Entity shall support one or more of the roles of File-set Creator, File-set Reader, and File-set Updater, defined in PS 3.10.

X.2.1.1 File Set Creator

The Application entity acting as a File-Set Creator generates a File Set under a STD-CTMR Application Profile. Typical entities using this role would include CT or MR equipment, and archive systems which generate a patient record for transfer to another institution. File Set Creators shall be able to generate the Basic Directory SOP Class in the DICOMDIR File with all types of Directory Records related to the SOP Classes stored in the File-set.

Note: A multiple volume (a logical volume that can cross multiple physical media) is not supported by this class of Application profile. If a set of Files, e.g., a Study, cannot be written entirely on one physical volume, the FSC will create multiple independent DICOM File-sets such that each File-set can reside on a single physical volume controlled by its individual DICOMDIR file. The user of the FSC can opt to use written labels on the physical volumes to indicate that there is more than one physical volume for this set of files (e.g., a study).

X.2.1.2 File Set Reader

The role of File Set Reader is used by Application Entities which receive a transferred File Set. Typical entities using this role would include display workstations, and archive systems which receive a patient record transferred from another institution. File Set Readers shall be able to read all the SOP Classes defined for the specific Application Profile for which a Conformance Statement is made, using all the defined Transfer Syntaxes.

X.2.1.3 File Set Updater

The role of File Set Updater is used by Application Entities which receive a transferred File Set and update it by the addition of information. Typical entities using this role would include analytic workstations, which, for instance, may add to the File-set an information object containing a processed image. Stations which update patient information objects would also use this role. File-set Updaters do not have to read the images. File-set Updaters shall be able to generate one or more of the SOP Instances defined for the specific Application Profile for which a conformance statement is made, and to read and update the DICOMDIR file.

Note: The File-set Updater shall be able to update information assuming there is enough space on the volume to write a new DICOMDIR file and the information.

X.3 STD-CTMR PROFILES

X.3.1 SOP Classes and Transfer Syntaxes

These Application Profiles are based on the Media Storage Service Class with the Interchange Option (see PS 3.4).

SOP Classes and corresponding Transfer Syntaxes supported by these Application Profiles are specified in the Table X.3.1-1.

Table X.3.1-1. STD-CTMR SOP Classes and Transfer Syntaxes

Information Object Definition	Service Object Pair Class UID	Transfer Syntax and UID	FSC Require-ment	FSR Require-ment	FSU Require-ment
Basic Directory	1.2.840.10008.1.3.10	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Mandatory	Mandatory	Mandatory
CT Image	1.2.840.10008.5.1.4.1.1.2	JPEG Lossless Process 14 (selection value 1) 1.2.840.10008.1.2.4.70	Optional	Mandatory	Optional
CT Image	1.2.840.10008.5.1.4.1.1.2	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Optional	Mandatory	Optional
MR Image	1.2.840.10008.5.1.4.1.1.4	JPEG Lossless Process 14 (selection value 1) 1.2.840.10008.1.2.4.70	Optional	Mandatory	Optional
MR Image	1.2.840.10008.5.1.4.1.1.4	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Optional	Mandatory	Optional
SC Image (grayscale)	1.2.840.10008.5.1.4.1.1.7	JPEG Lossless Process 14 (selection value 1) 1.2.840.10008.1.2.4.70	Optional	Mandatory	Optional
SC Image (grayscale)	1.2.840.10008.5.1.4.1.1.7	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Optional	Mandatory	Optional
SC Image (palette color)	1.2.840.10008.5.1.4.1.1.7	JPEG Lossless Process 14 (selection value 1) 1.2.840.10008.1.2.4.70	Optional	Optional	Optional
SC Image (palette color)	1.2.840.10008.5.1.4.1.1.7	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Optional	Optional	Optional
Detached Patient Management	1.2.840.10008.3.1.2.1.1	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Optional	Defined in Conformance Statement (See X.3.4.1.1)	Optional

X.3.2 Physical Medium And Medium Format

The STD-CTMR-MOD650 application profile requires the 130 mm 650MB R/W MOD physical medium with the PCDOS Media Format, as defined in PS 3.12.

The STD-CTMR-MOD12 application profile requires the 130 mm 1.2GB R/W MOD physical medium with the PCDOS Media Format, as defined in PS 3.12.

The STD-CTMR-MOD23 application profile requires the 130 mm 2.3GB R/W MOD physical medium with the PCDOS Media Format, as defined in PS 3.12.

The STD-CTMR-CD application profile requires the 120 mm CD-R physical medium with the ISO 9660 Media Format, as defined in PS 3.12.

X.3.3 Directory Information in DICOMDIR

Conformant Application Entities shall include in the DICOMDIR File a Basic Directory IOD containing Directory Records at the Patient and subsidiary levels appropriate to the SOP Classes in the File-set. All DICOM files in the File-set incorporating SOP Instances defined for the specific Application Profile shall be referenced by Directory Records.

Note: DICOMDIRs with no directory information are not allowed by this Application Profile.

X.3.3.1 Additional Keys

File Set Creators and Updaters are required to generate the mandatory elements specified in PS 3.3, Annex F of the standard. Table X.3.3.1-1 specifies the additional associated keys. At each directory record level other additional data elements can be added, but it is not required that File Set Readers be able to use them as keys. Refer to the Basic Directory IOD in PS 3.3.

X.3.3.2 Localizer Related Attributes

Directory Records of type IMAGE shall include the mandatory attributes from the Frame of Reference and Image Plane modules, if present in the composite image object, as specified in PS3.3 and included in Table X.3.3.1-1, in order to allow the image to be referenced to a localizer image or other orthogonal image. The Rows (0028,0010) and Columns (0028,0011) attributes are required in order to facilitate annotation of such a localizer.

Note: The Frame of Reference module is specified in PS 3.3 as mandatory for the CT and MR composite information objects, but not for Secondary Capture objects.

X.3.3.3 Icon Images

Directory Records of type SERIES or IMAGE may include Icon Images. The icon pixel data shall be as specified in PS 3.3 Icon Image Key Definition, and restricted such that Photometric Interpretation (0028,0004) shall be MONOCHROME2 or PALETTE COLOR, Bits Allocated (0028,0100) and Bits Stored (0028,0101) shall be equal to 8, and Rows (0028,0010) and Columns (0028,0011) shall be equal to 64.

X.3.4 Other Parameters

This section defines other parameters in the STD-CTMR profiles which need to be specified in order to ensure interoperable information interchange.

Table X.3.3.1-1 STD-CTMR Additional DICOMDIR Keys

Key Attribute	Tag	Record Type	Type	Notes
Referenced Image Sequence	(0008,1140)	IMAGE	1C	Required if present in image object.
>Referenced SOP Class UID	(0008,1150)	IMAGE	1C	Required if Referenced Image Sequence (0008,1140) is present.
>Referenced SOP Instance UID	(0008,1155)	IMAGE	1C	Required if Referenced Image Sequence (0008,1140) is present.
Image Position (Patient)	(0020,0032)	IMAGE	1C	Required if present in image object.
Image Orientation (Patient)	(0020,0037)	IMAGE	1C	Required if present in image object.
Frame of Reference UID	(0020,0052)	IMAGE	1C	Required if present in image object.
Rows	(0028,0010)	IMAGE	1	
Columns	(0028,0011)	IMAGE	1	
Pixel Spacing	(0028,0030)	IMAGE	1C	Required if present in image object.

Notes: 1. The Basic Directory Information Object definition in PS 3.3 defines the following attributes as Type 1 or 2: for PATIENT directory records: (0010,0010) Patient's Name; for STUDY directory records: (0008,0050) Accession Number, (0008,0020) Study Date, (0008,1030) Study Description; for SERIES directory records: (0008,0060) Modality. Hence these are not redefined here.

2. The Basic Directory Information Object definition in PS 3.3 allows for the optional inclusion of Icon Images at the IMAGE or SERIES level. These remain optional for this profile, and the choice of whether or not to include Icon Images for every image or series, or in a more selective manner, is left up to the implementor. X.3.3.3 describes restrictions that apply to Icon Images that are included in this profile.

X.3.4.1 Image Attribute Values

The attributes listed in Table X.3.4.1-1 used within CT Image files, those listed in Table X.3.4.1-2 used within MR Image files, , those listed in Table X.3.4.1-3 used within grayscale SC Image files, and those listed in Table X.3.4.1-4 used within color SC Image files, shall take the values specified, which are more specific than, but must be consistent with, those specified in the definition of the CT, MR and SC Image Information Object Definitions in PS 3.3.

Table X.3.4.1-1 STD-CTMR
Required Image Attribute Values for CT Images

Attribute	Tag	Value
Modality	(0008,0060)	CT
Photometric Interpretation	(0028,0004)	MONOCHROME2

Table X.3.4.1-2 STD-CTMR
Required Image Attribute Values for MR Images

Attribute	Tag	Value
Modality	(0008,0060)	MR
Photometric Interpretation	(0028,0004)	MONOCHROME2
Bits Stored	(0028,0101)	8,12 to 16
High Bit	(0028,0102)	(0028,0101) Bits Stored - 1

Note: The definition of the MR Composite Image Object in PS 3.3 does not restrict (0028,0101) Bits Stored or (0028,0102) High Bit.

Table X.3.4.1-3 STD-CTMR
Required Image Attribute Values for Grayscale SC Images

Attribute	Tag	Value
Samples Per Pixel	(0028,0002)	1
Photometric Interpretation	(0028,0004)	MONOCHROME2
Bits Allocated	(0028,0100)	8 or 16
Bits Stored	(0028,0101)	(0028,0100) Bits Allocated
High Bit	(0028,0102)	(0028,0101) Bits Stored - 1

Table X.3.4.1-4 STD-CTMR
Required Image Attribute Values for Color SC Images

Attribute	Tag	Value
Samples Per Pixel	(0028,0002)	1
Photometric Interpretation	(0028,0004)	PALETTE COLOR
Bits Allocated	(0028,0100)	8
Bits Stored	(0028,0101)	8
High Bit	(0028,0102)	7

X.3.4.1.1 Attribute Value Precedence

If an FSR supports the Detached Patient Management SOP Class, the values of attributes contained in a Detached Patient Management SOP Instance referenced by a Directory Record of type PATIENT, shall take precedence over the values of those attributes contained in the SOP Instance referenced by a subsidiary Directory Record. The DICOMDIR Directory Records of type PATIENT shall have key attributes values in accordance with this precedence.

Note: 1. This allows patient identification and demographic information to be updated without changing the composite Image IOD files. The DICOMDIR file thus is critical in establishing the link between the updated information and the image. As an example, at the time an Image file was written, the patient's name therein was incorrect, or inconsistent with the Hospital Informations System records. Subsequently, a Detached Patient Management file with the corrected name is added to the File Set. The FSR should use the information from the Detached Patient Management SOP Class, rather than the information in the Image file.

2. The support for the Detached Patient Management SOP Class as indicated in Table X.3.1-1, is to be defined in the Conformance Statement, and is not mandatory for all FSRs of this profile. Applications which require the ability to read updated patient identifying information, such as an FSR that may forward an updated SOP Instance elsewhere, may need to support this mechanism. Applications such as standalone viewers may choose not to support this mechanism, in which case the user should be made aware, for example by a screen message or in the documentation, that updated identifying information may exist on the media that is not visible.