Digital Imaging and Communications in Medicine (DICOM)

Supplement 80: DVD Media Application Profiles

DICOM Standards Committee, Working Group 5 Interchange Media

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29 **Contents**

New clinical applications have requirements for higher capacity media formats. This is true for general-purpose applications and is also especially important in the support of the 1024 matrix size that is becoming more common for digital coronary angiography. General (peripheral and neuro) angiography similarly requires significantly higher capacity than is afforded by CD-R.

DVD-RAM was introduced into the standard with Supplement 40 but is not suitable for some applications, particularly since it is not readable on many users' PCs without a special drive. At the time, support for DVD-R and DVD-RW and DVD+RW was not added to the standard due to lack of a clear consensus as to which medium would prove popular as well as the lack of multiple vendors for media and drives. This situation has now changed, with multiple vendors available for all these media types.

The question remains then as to which to pick for new DICOM interchange applications. Since there are few if any fair or meaningful criteria on which to make such a choice, and since the ability to interchange media that may be rewritten seems to be less important for many applications than the need to be able to write an entire piece of media and read it elsewhere, the unusual choice of excluding the File Set Updater role and specifying only the File Set Creator and Reader roles in a media-agnostic manner has been taken.

CHOICE OF A FILESYSTEM

All DVD media makes use of the UDF file system. DVD-RAM as presently supported in the standard defines the use of UDF 1.5.

The need to specify the level of UDF that must be supported by a File Set Reader is avoided by specifying that an FSR must be able to read any UDF version up to 2.01 (the most recent version), since that implies that earlier versions (1.02, 1.5 and 2.0) will also be supported.

Mandatory support for reading both UDF and ISO 9660 is included to facilitate migration from legacy CD-R implementations, which use ISO 9660, as well as to support the industry standard filesystem for DVD, UDF.

CHOICE OF A PHYSICAL MEDIUM

It should be stressed that DICOM is not attempting to standardize an archive medium, only an interchange medium (though many applications typically write interchange media using the same physical drive and software as is used for writing single archival volumes for shelf management). It is, however, desirable that media chosen for interchange be resilient and non-volatile.

The input of other working groups that may use new media has been sought. While the ultrasound working group (Working Group 12) places a high priority on rewritable media and is interested in a replacement for magneto-optical disc ("MOD"), the Cardiovascular Information Group (Working Group 1) places a high priority on the ability to be "ubiquitously readable". That is, the ability to read the media on any modern PC without additional specialized hardware. The DVD-R, DVD-RW, DVD+R, DVD+RW, and DVD-ROM) media meets this ubiquitous readability requirement, as they can be read in the vast majority of conventional DVD-ROM drives used today (DVD-RAM does not share this feature).

Furthermore, the rewritable feature requested by WG12 for "internal" departmental use and reusability is felt by WG1 to be a potentially undesirable feature for exchanging information between institutions, as growing concerns about security and confidentiality are better addressed by an exchange format that cannot readily be altered. To assure that data has not been altered requires the use of cryptographic security mechanisms such as those defined in PS 3.15, but the use of disk-at-once writing of ablative media such as DVD-R goes some way to meeting this requirement. Incremental writing of DVD-RW or DVD+RW does not meet this requirement.

Finally, it is recognized that there is a need (albeit rare) to mass-produce media content on DVD-ROM (for example, for teaching purposes). As this meets the requirements of “ubiquitously readable”, and is fully compatible with DVD-R file formats and readers, this media is also included on the list of acceptable media.

An allied consideration is that of the ability to append information onto media. Historically, this feature was included in the CD-R application profile, with the intent that “core labs” might want to add information such as secondary captures onto the recorded media. This feature has been used rarely (if at all), and in routine practice; CD-R media containing DICOM information is not altered after written. As mentioned above, one of the current concerns in the area of medical information security and confidentiality is the assurance that what is received is in fact exactly what was sent. For these reasons, the DVD application profile does not include a description of a File Set Updater. With this capability removed, the ability to assure the integrity of the data is increased, and interoperability is improved, as the precise format and wavelength response of the media does not need to be specified or adhered to (this is purely a consideration for the File Set Creator and its associated DVD-R recorder).

As described in the Scope and Field of Application of Supplement 40, when the suggestions of the various groups were taken into account, it became apparent that no single choice of DVD-based media would satisfy the unique requirements of every application. Accordingly, it was decided that the specific types of DVD media would be added to the standard as the need arises and as the technology becomes available from multiple media and drive vendors.

UPDATE APPLICATION PROFILES

This supplement also takes the opportunity to modernize the 1K angio and CT/MR profiles by removing support for the standalone and detached patient management SOP Classes.

FORM OF THIS SUPPLEMENT

This supplement defines the use of DVD-R, DVD-RW, DVD+R, DVD+RW, and DVD-ROM. It defines the “reading” aspects of the media, as there are several media formats that can be created that are compatible with the reading requirements of this profile.

It specifies the use of the Universal Disk Format (UDF) with any version up to 2.01, and ISO 9660 Levels 1, 2 and 3.

Media Application Profiles are defined for 1K XA Images, US Images, General Purpose applications and CT/MR.

This Supplement makes changes to the following existing Parts of DICOM:

- PS 3.11 Addendum: Media Storage Application Profiles

- PS 3.12 Addendum: Media Formats and Physical Media

PS 3.11: Add DVD profile to Annex B – 1024 X-ray Angiographic Application Profile, and update SOP Classes supported.

B.1 CLASS AND PROFILE IDENTIFICATION

This Annex defines a class of Application Profiles for 1024 X-ray Angiographic clinical applications. The identifier for this class shall be STD-XA1K. It is the intent of ~~this~~ **these** profile**s** to be backward compatible with the Basic Cardiac X-ray Angiographic Application Profile (STD-XABC-CD) in PS 3.11 Annex A.

The specific Application Profiles in this class are shown in the Table 1.

Application Profile	Identifier	Description
1024 X-Ray Angiographic Studies on CD-R Media	STD-XA1K-CD	It handles single frame or multi-frame x-ray digital images up to 1024x1024x12 bits; biplane acquisitions are encoded as two single plane information objects. Secondary Capture images are supported.
1024 X-Ray Angiographic Studies on DVD Media	**STD-XA1K-DVD**	**It handles single frame or multi-frame x-ray digital images up to 1024x1024x12 bits; biplane acquisitions are encoded as two single plane information objects. Secondary Capture images are supported.**

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B.2.1.1 File Set Creator

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An FSC shall offer the ability to either finalize the disc at the completion of the most recent write session (no additional information can be subsequently added to the disc) or to allow multi-session (additional information may be subsequently added to the disc). **An FSC may allow packet-writing if supported by the media and file system specified in the profile**.

Note: A multiple volume (a logical volume that can cross multiple physical media) is not supported by this Application Profile Class. If a set of Files, e.g., a Study, cannot be written entirely on one ~~**CD-R**~~ **piece of media**, the FSC will create multiple independent DICOM File-set such that each File-set can reside on a single ~~**CD-R**~~ **piece of** medi~~**um**~~**a** controlled by its individual DICOMDIR file. The user of the FSC can opt to use written labels on the discs to reflect that there is more than one disc for this set of files (e.g., a Study).

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B.2.1.3 File Set Updater

The role of File Set Updater shall be used by Application Entities which receive a transferred File Set and update it by the addition of processed 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 (e.g., edge-enhanced) image frame. Stations which update patient information objects would also use this role. File-set Updaters shall be able to read and update the DICOMDIR file. File-set Updaters do not have to read the image information object. File-set Updaters shall be able to generate any of the SOP Instances files defined for the specific Application Profiles to which a conformance claim is made, and to read and update the DICOMDIR file.

An FSU shall offer the ability to either finalize the disc at the completion of the most recent write session (no additional information can be subsequently added to the disc) or to allow multi-session (additional information may be subsequently added to the disc).

Note: If the disc has not been finalized, the File-set Updater will be able to update information assuming there is enough space on the disc to write a new DICOMDIR file, the information, and the fundamental ~~CD-R~~ **volume** control structures. ~~CD-R~~ **Volume** control structures are the structures that are inherent to the ~~CD-R media~~ standards **of the physical volume**; see PS 3.12**.**

The FSU role is not defined for the STD-XA1K-DVD profile.

B.3 STD-XA1K-~~CD~~ APPLICATION PROFILE CLASS REQUIREMENTS

B.3.1 SOP Classes and Transfer Syntaxes

This Application Profile **Class** is based on the Media Storage Service Class with the Interchange Option (see PS 3.4).

SOP Classes and corresponding Transfer Syntaxes supported by this Application Profile are specified in Table B.3-1.

Table B.3-1
STD-XA1K-~~CD~~ SOP Classes and Transfer Syntaxes

Information Object Definition	Service Object Pair Class UID	Transfer Syntax and UID	FSC Requirement	FSR Requirement	FSU Requirement (See note 1)
Basic Directory	1.2.840.10008.1.3.10	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Mandatory	Mandatory	Mandatory
X-Ray Angiographic Image	1.2.840.10008.5.1.4.1.1.12.1	JPEG Lossless Process 14 (selection value 1) 1.2.840.10008.1.2.4.70	Mandatory	Mandatory	Optional
X-Ray Angiographic Image	**1.2.840.10008.5.1.4.1.1.12.1**	**JPEG Lossy, Baseline Sequential with Huffman Coding (Process 1) 1.2.840.10008.1.2.4.50**	**Optional for DVD; Disallowed for CD**	**Mandatory for DVD; Disallowed for CD**	**Undefined for DVD; Disallowed for CD**
Secondary Capture Image Storage	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
Grayscale Softcopy Presentation State Storage	**1.2.840.10008.5.1.4.1.1.11.1**	**Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1**	**Optional**	**Optional**	**Optional**

~~Standalone Overlay~~	~~1.2.840.10008.5.1.4.1.1.8~~	~~Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1~~	~~Optional~~	~~Optional~~	~~Optional~~
~~Standalone Curve~~	~~1.2.840.10008.5.1.4.1.1.9~~	~~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~~	~~Mandatory~~	~~Optional~~

Notes: 1. The FSU requirement is not defined for STD-XA1K-DVD profile.

2. The Standalone Overlay, Standalone Curve and Detached Patient management SOP Classes were formerly defined in these profiles, but have been retired. The Grayscale Softcopy Presentation State Storage SOP Class has been added as the preferred mechanism for conveying annotations.

B.3.2 Physical Media And Media Formats

The 1024 X-Ray Angiographic Application **CD-R** Profile~~s in the~~ STD-XA1K**-CD** ~~class~~ require**s** the 120 mm CD-R physical media with the ISO/IEC 9660 Media Format, as defined in PS3.12.

The 1024 X-Ray Angiographic Application DVD profile STD-XA1K-DVD requires any of the 120 mm DVD media other than DVD-RAM as defined in PS 3.12.

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B.3.3.1 Additional Keys

Table B.3-2 specifies the type of Directory Records that shall be supported and the additional associated keys. Refer to the Basic Directory IOD in PS3.3.

Table B.3-2
STD-XA1K Additional DICOMDIR Keys

Key Attribute	Tag	Directory Record Level	Type	Notes
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Lossy image Compression Ratio	**(0028,2112)**	**IMAGE**	**1C**	**Required if present in image object with a non-zero length value.**

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B.3.4.3 Attribute Value Precedence

~~The values of attributes contained in a Detached Patient Management SOP Instance referenced by a DICOMDIR PATIENT Directory Record shall take precedence over the values of those attributes contained in a SOP Instance referenced by a subsidiary Directory Record. The DICOMDIR Directory Records shall have key attribute values in accordance with this precedence.~~

~~Note: 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 Information System records. Subsequently, a Detached Patient Management file with the corrected name is added to the file-set. The FSR should use the name from the Patient file rather than the name in the Image file.~~

Retired.

PS 3.11: Add DVD profile to Annex C – Ultrasound Application Profile.

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C.2.1 Roles

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C.2.1.3 FILE SET UPDATER

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The FSU role is not defined for the STD-US-xx-xx-DVD profiles (i.e. for DVD media that is not DVD-RAM).

C.3 GENERAL CLASS PROFILE

C.3.2 Physical Media and Media Formats

An ultrasound application profile class may be supported by any one of the media described in Table C.3-3.

Table C.3-3
MEDIA CLASSES

Media	Media Classes	Media Format	PS 3.12
1.44 MB Floppy Disc	FLOP	DOS	Annex B
128 MB 90 mm MOD	MOD128	DOS, unpartitioned (removable media)	Annex C
230 MB 90 mm MOD	MOD230	DOS, unpartitioned (removable media)	Annex G
540 MB 90 mm MOD	MOD540	DOS, unpartitioned (removable media)	Annex H
650MB 130 mm MOD	MOD650	DOS, unpartitioned (removable media)	Annex D
1.2GB 130 mm MOD	MOD12	DOS, unpartitioned (removable media)	Annex E
2.3GB 130 mm MOD	MOD23	DOS, unpartitioned (removable media)	Annex I
CD-R	CDR	ISO~~/IEC~~ 9660	Annex F
DVD-RAM	DVD-RAM	UDF 1.5	Annex J
120 mm DVD	**DVD**	**UDF or ISO 9660**	**Annex X**

PS 3.11: Add DVD profile to Annex E – CT and MR Application Profiles:

E.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 and DVD-RAM **and other DVD media** uncompressed and with lossless compression.

Table E.1-1 - 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 4.1GB MOD	STD-CTMR-MOD41	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.
CT/MR Studies on DVD-RAM Media	STD-CTMR-DVD-RAM	Handles single frame 8, 12 or 16 bit grayscale and 8 bit palette color, uncompressed and lossless compressed images.
CT/MR Studies on DVD Media	**STD-CTMR-DVD**	**Handles single frame 8, 12 or 16 bit grayscale and 8 bit palette color, uncompressed and lossless compressed images.**

E.2.1.3 File Set Updater

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The FSU role is not defined for the STD-CTMR-DVD profile.

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E.3 STD-CTMR PROFILES

E.3.1 SOP Classes and Transfer Syntaxes

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Table E.3-1
STD-CTMR SOP Classes and Transfer Syntaxes

Information Object Definition	Service Object Pair Class UID	Transfer Syntax and UID	FSC Requirement	FSR Requirement	FSU Requirement (see note)
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 E.3.4.1.1)**~~	~~**Optional**~~

Notes: 1. The FSU requirement is not defined for STD-CTMR-DVD profile.

2. The Detached Patient management SOP Class was formerly defined in these profiles, but has been retired.

E.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-MOD41 application profile requires the 130 mm 4.1GB 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.

The STD-CTMR-DVD-RAM application profile requires the 120 mm DVD-RAM medium, as defined in PS 3.12.

The STD-CTMR-DVD application profile requires any of the 120 mm DVD media other than DVD-RAM, as defined in PS 3.12.

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E.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 E.3-1, 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.**~~

Retired.

PS 3.11: Add new General Purpose DVD Application Profiles with compression:

Annex X (Normative) - General Purpose DVD with Compression Interchange Profiles

X.1 PROFILE IDENTIFICATION

This Annex defines an Application Profile Class potentially inclusive of all defined Media Storage SOP Classes. This class is intended to be used for the interchange of Composite SOP Instances via DVD media for general purpose applications. Objects from multiple modalities may be included on the same media. Images may be compressed with or without loss using either JPEG or JPEG 2000; all readers shall support compression.

A detailed list of the Media Storage SOP Classes that may be supported is defined in PS 3.4.

Table X.1-1 STD-GEN-DVD and STD-GEN-SEC-DVD Profiles

Application Profile	Identifier	Description
General Purpose DVD Interchange with JPEG	STD-GEN-DVD-JPEG	Handles interchange of Composite SOP Instances such as Images, Structured Reports, Presentation States and Waveforms, either uncompressed or with lossless or lossy JPEG.
General Purpose DVD Interchange with JPEG 2000	STD-GEN-DVD-J2K	Handles interchange of Composite SOP Instances such as Images, Structured Reports, Presentation States and Waveforms, either uncompressed or with lossless or lossy JPEG 2000.
General Purpose Secure DVD Interchange with JPEG	STD-GEN-SEC-DVD-JPEG	Handles interchange of Composite SOP Instances such as Images, Structured Reports, Presentation States and Waveforms, either uncompressed or with lossless or lossy JPEG. Offers confidentiality, integrity and, depending on the File-set creator's choice, data origin authentication.
General Purpose Secure DVD Interchange with JPEG 2000	STD-GEN-SEC-DVD-J2K	Handles interchange of Composite SOP Instances such as Images, Structured Reports, Presentation States and Waveforms, either uncompressed or with lossless or lossy JPEG 2000. Offers confidentiality, integrity and, depending on the File-set creator's choice, data origin authentication.

Equipment claiming conformance to this Application Profile shall list the subset of Media Storage SOP Classes that it supports in its Conformance Statement.

Note: Since it is not required to support all Media Storage Classes the user should carefully consider the subset of supported Media Storage SOP Classes in the Conformance Statements of such equipment to establish effective object interchange.

X.2 CLINICAL CONTEXT

This Application Profile Class facilitates the interchange of images and related data on DVD media. Typical interchange would be between acquisition devices, archives and workstations.

This Application Profile Class facilitates the creation of a multi-modality medium for image interchange, useful for clinical, patient record, teaching and research applications, within and between institutions.

This profile is intended only for general purpose applications. It is not intended as a replacement for specific Application Profiles that may be defined for a particular clinical context.

Note: The creation of a DVD is considerably more complex than the reading thereof. Therefore the clinical context for this Application profile is likely to be asymmetric, with a sophisticated File Set Creator and relatively simple File Set Readers.

X.2.1 Roles and Service Class Options

This Application Profile Class uses the Media Storage Service Class defined in PS3.4 with the Interchange Option.

The Application Entity shall support one or more of the roles of File Set Creator (FSC) or File Set Reader (FSR) , defined in PS 3.10. The File Set Updater (FSU) role is not defined.

X.2.1.1 File Set Creator

The role of File Set Creator shall be used by Application Entities which generate a File Set under this Image Interchange Class of Application Profiles.

File Set Creators shall be able to generate the Basic Directory SOP Class in the DICOMDIR file with all the subsidiary Directory Records related to the Image SOP Classes stored in the File Set.
The Application Entity acting as a File Set Creator generates a File Set under a STD-GEN-DVD or STD-GEN-SEC-DVD Application Profile.

FSC shall offer the ability to either finalize the physical volume at the completion of the most recent write session (no additional information can be subsequently added to the volume) or to allow multi-session (additional information may be subsequently added to the volume). An FSC may allow packet-writing, if supported by the media and file system specified in the profile.

Note: A multiple volume (i.e. 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 (side of one piece of media), the FSC will create multiple independent DICOM File Sets such that each File Set can reside on a single physical volume (side of a single piece of media) 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 shall be used by Application Entities which receive a transferred File Set under the Image Interchange Class of Application Profiles. Typical entities using this role would include image generating systems, display workstations, and archive systems which receive a patient record; e.g. transferred from another institution.

File Set Readers shall be able to read the DICOMDIR directory file and all the SOP Instance files defined for this Application Profile, for which a Conformance Statement is made, using all the defined Transfer Syntaxes for the Profile.

Note: All Transfer Syntaxes defined in the profile must be supported by the FSR. It is not permissible to only support one or other of the uncompressed or the compressed Transfer Syntaxes.

X.2.1.3 File Set Updater

The FSU role is not defined for the STD-GEN-DVD and STD-GEN-SEC-DVD profiles.

X.3 STD-GEN-DVD AND STD-GEN-SEC-DVD PROFILE CLASSES

X.3.1 SOP Classes and Transfer Syntaxes

This Application Profile is based on the Media Storage Service Class with the Interchange Option (see PS 3.4).

Table X.3-1
STD-GEN-DVD and STD-GEN-SEC-DVD SOP Classes and Transfer Syntaxes

Information Object Definition	Service Object Pair Class UID	Transfer Syntax and UID	FSC Requirement	FSR Requirement
Basic Directory	1.2.840.10008.1.3.10	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Mandatory	Mandatory
Composite IODs for which a Media Storage SOP Class is defined in PS 3.4	*See PS 3.4*	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Defined in Conformance Statement	Mandatory for all SOP Classes defined in Conformance Statement
Composite IODs for which a Media Storage SOP Class is defined in PS 3.4	*See PS 3.4*	JPEG Lossless Process 14 (selection value 1) 1.2.840.10008.1.2.4.70	Defined in Conformance Statement	Mandatory for –JPEG profiles for all SOP Classes defined in Conformance Statement
Composite IODs for which a Media Storage SOP Class is defined in PS 3.4	*Refer to: PS 3.4*	JPEG Lossy, Baseline Sequential with Huffman Coding (Process 1) 1.2.840.10008.1.2.4.50	Defined in Conformance Statement	Mandatory for –JPEG profiles for all SOP Classes defined in Conformance Statement
Composite IODs for which a Media Storage SOP Class is defined in PS 3.4	*Refer to: PS 3.4*	JPEG Extended (Process 2 & 4): Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only) 1.2.840.10008.1.2.4.51	Defined in Conformance Statement	Mandatory for –JPEG profiles for all SOP Classes defined in Conformance Statement
Composite IODs for which a Media Storage SOP Class is defined in PS 3.4	*Refer to: PS 3.4*	JPEG 2000 Image Compression (Lossless Only) 1.2.840.10008.1.2.4.90	Defined in Conformance Statement	Mandatory for –J2K profiles for all SOP Classes defined in Conformance Statement

Composite IODs for which a Media Storage SOP Class is defined in PS 3.4	*Refer to: PS 3.4*	JPEG 2000 Image Compression 1.2.840.10008.1.2.4.91	Defined in Conformance Statement	Mandatory for –J2K profiles for all SOP Classes defined in Conformance Statement

The SOP Classes and corresponding Transfer Syntax supported by this Application Profile are specified in the Table X.3-1. The supported Storage SOP Class(es) shall be listed in the Conformance Statement using a table of the same form.

X.3.2 Physical Medium And Medium Format

The STD-GEN-DVD and STD-GEN-SEC-DVD application profiles require any of the 120 mm DVD media other than DVD-RAM, as defined in PS 3.12.

X.3.3 Directory Information in DICOMDIR

Conformant Application Entities shall include in the DICOMDIR File the Basic Directory IOD containing Directory Records at the Patient and the subsidiary Study and Series 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.

All implementations shall include the DICOM Media Storage Directory in the DICOMDIR file. There shall only be one DICOMDIR file per File Set. The DICOMDIR file shall be in the root directory of the medium. The Patient ID at the patient level shall be unique for each patient directory record in one File Set.

X.3.3.1 Additional Keys

File Set Creators and Updaters are required to generate the mandatory elements specified in PS 3.3.

Table X.3-2 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.

401 **Table X.3-2**
402 **STD-GEN-DVD and STD-GEN-SEC-DVD Additional DICOMDIR Keys**

Key Attribute	Tag	Directory Record Type	Type	Notes
Patient's Birth Date	(0010,0030)	PATIENT	1C	Required if present in any objects referenced by subordinate records with a non-zero length value.
Patient's Sex	(0010,0040)	PATIENT	1C	Required if present in any objects referenced by subordinate records with a non-zero length value.
Institution Name	(0008,0080)	SERIES	1C	Required if present in any objects referenced by subordinate records with a non-zero length value.
Institution Address	(0008,0081)	SERIES	1C	Required if present in any objects referenced by subordinate records with a non-zero length value.
Performing Physicians' Name	(0008,1050)	SERIES	1C	Required if present in any objects referenced by subordinate records with a non-zero length value.
Image Type	(0008,0008)	IMAGE	1C	Required if present in image object.
Calibration Image	(0050,0004)	IMAGE	1C	Required if present in image object with a non-zero length value.
Referenced Image Sequence	(0008,1140)	IMAGE or SPECTROSCOPY	1C	Required if present in image object with one or more items, either in the top level dataset or nested within a functional group sequence of the Shared Functional Groups Sequence (5200,9229).
Lossy Image Compression Ratio	(0028,2112)	IMAGE	1C	Required if present in image object with a non-zero length value.
Rows	(0028,0010)	IMAGE or SPECTROSCOPY	1	
Columns	(0028,0011)	IMAGE or SPECTROSCOPY	1	
Frame of Reference UID	(0020,0052)	IMAGE or SPECTROSCOPY	1C	Required if present in image or spectroscopy object.
Synchronization Frame of	(0020,0200)	IMAGE or	1C	Required if present in

Reference UID		SPECTROSCOPY		image or spectroscopy object.
Number of Frames	(0028,0008)	IMAGE or SPECTROSCOPY	1C	Required if present in image or spectroscopy object.
Acquisition Time Synchronized	(0018,1800)	IMAGE or SPECTROSCOPY	1C	Required if present in image or spectroscopy object.
Acquisition Datetime	(0008,002A)	IMAGE or SPECTROSCOPY	1C	Required if present in image or spectroscopy object.
Image Position (Patient)	(0020,0032)	IMAGE or SPECTROSCOPY	1C	Required if present in image or spectroscopy object, either in the top level dataset or nested within a functional group sequence of the Shared Functional Groups Sequence (5200,9229).
Image Orientation (Patient)	(0020,0037)	IMAGE or SPECTROSCOPY	1C	Required if present in image or spectroscopy object, either in the top level dataset or nested within a functional group sequence of the Shared Functional Groups Sequence (5200,9229).
Pixel Spacing	(0028,0030)	IMAGE or SPECTROSCOPY	1C	Required if present in image or spectroscopy object, either in the top level dataset or nested within a functional group sequence of the Shared Functional Groups Sequence (5200,9229).

Note: The requirements with respect to the mandatory DICOMDIR keys in PS 3.3 imply that either these attributes are present in the Image IOD, or they are in some other way supplied by the File-set Creator. These attributes are (0010,0020) Patient ID, (0008,0020) Study Date, (0008,0030) Study Time, (0020,0010) Study ID, (0020,0011) Series Number, and (0020,0013) Instance Number.

X.3.4 Other Parameters

X.3.4.2 Multiframe JPEG Format

The JPEG encoding of pixel data shall use Interchange Format (with table specification) for all frames.

X.3.5 Security Parameters

The STD-GEN-SEC-DVD application profiles require that all DICOM Files in the File-set including the DICOMDIR be Secure DICOM Files encapsulated in accordance with the requirements of the Basic DICOM Media Security Profile as defined in PS 3.15.

Note: These Application Profiles do not place any consistency restrictions on the use of the Basic DICOM Media Security Profile with different DICOM Files of one File-set. For example, readers should not assume that all Files in the File-set can be decoded by the same set of recipients. Readers should also not assume that all secure Files use the same approach (hash key or digital signature) to ensure Integrity or carry the same originators' signatures.

Update PS 3.12 references and definitions sections:

2 Normative references

DVD Forum. DVD Specifications for Rewritable Disc (DVD-RAM 4.7GB): Part 1 - Physical Specifications Version 2.0.

Note: This reference will be replaced by the corresponding ISO or ECMA reference when available.

DVD Forum. DVD Specifications for Rewritable Disc (DVD-RAM 4.7GB): Part 2 – File System Specifications Version 2.0.

Note: This reference will be replaced by the corresponding ISO or ECMA reference when available.

DVD Forum. DVD Specifications for Recordable Disc (DVD-R for General): Part 1 - Physical Specifications Version 2.0.

DVD Forum. DVD Specifications for Recordable Disc (DVD-R for General): Part 2 – File System Specifications Version 2.0.

DVD Forum. DVD Specifications for Recordable Disc (DVD-R for Authoring): Part 1 - Physical Specifications Version 2.0.

DVD Forum. DVD Specifications for Recordable Disc (DVD-R for Authoring): Part 2 – File System Specifications Version 2.0.

DVD Forum. DVD Specifications for Read-Only Disc (DVD-ROM): Part 1 - Physical Specifications Version 1.13.

DVD Forum. DVD Specifications for Read-Only Disc (DVD-ROM): Part 2 – File System Specifications Version 1.13.

DVD Forum. DVD Specifications for Re-Recordable (DVD-RW): Part 1 - Physical Specifications Version 1.1.

DVD Forum. DVD Specifications for Re-Recordable Disc (DVD-RW): Part 2 – File System Specifications Version 1.0.

DVD+ Alliance. DVD+RW Physical Specifications, Version 1.1, September 2001.

DVD+ Alliance. DVD+RW Defect Management & Physical Formatting Specification, Version 1.0, December 2001.

DVD+ Alliance. DVD+R Physical Specifications, Version 1.1, August 2002.

Note: These references will be replaced by the corresponding ISO or ECMA reference when available.

RFC 3240, Digital Imaging and Communications in Medicine (DICOM) - Application/dicom MIME Sub-type Registration

ISO/IEC IS 15286:1999 Data Interchange on 130mm Optical Disk Cartridges - Capacity 5.2GB Per Cartridge.

IEEE P1282. Rock Ridge Interchange Protocol. 1994.

Joliet Specification CD-ROM Recording Spec ISO 9660:1988. Microsoft Corporation. May 22, 1995.

…

4 Symbols and abbreviations

The following symbols and abbreviations are used in this part of the standard.

…

DVD-R **DVD Recordable**

DVD-ROM **DVD Read-Only Memory**

DVD-RW **DVD Rewritable**

DVD+R **DVD Plus Recordable**

DVD+RW **DVD Plus Rewritable**

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Add new Annex X to PS 3.12 (NB. This in addition to, and does not amend or replace Annex J on DVD-RAM):

Annex X 120 mm DVD Medium (Normative)

This Annex defines the use of the UDF and ISO 9660 file systems with DVD media in such a manner as to require a reader to be capable of reading all of the physical media types and UDF and ISO 9660 file system versions that are defined in this Annex, and a creator to be able to create at least one of those types of media and file system.

The media types supported are DVD-ROM, DVD-R authoring and general, DVD-RW, DVD+R and DVD+RW.

Notes: 1. Capitalization in this annex may be inconsistent with other DICOM standards in order to be consistent with historical usage for terms in referenced documents.

2. Mandatory support for reading both UDF and ISO 9660 is included to facilitate migration from legacy CD-R implementations, which use ISO 9660, as well as to support the industry standard filesystem for DVD, UDF.

Universal Disk Format (UDF) is a profile of the ECMA 167 3rd edition file system.

Notes: 1. The ECMA 167 3rd edition is more recent than ISO 13346:1995 which is equivalent to ECMA 167 2nd edition.

2. A reader of a UDF 2.01 file system can also read a 2.0, 1.5 or 1.02 file system.

X.1 DICOM MAPPING TO MEDIA FORMAT

X.1.1 Media Character Set

The character set used in UDF fields shall be the CS0 OSTA Compressed Unicode character set, required by the UDF standard.

Notes: 1. The CS0 OSTA Unicode character set is defined in UDF and is a subset of Unicode 2.0.

2. UDF defines a specific form of compression of 8 and 16 bit Unicode characters that must be supported.

3. The character set defined elsewhere in this section for DICOM File-set fields is a subset of this character set. However other fields in the UDF file system, and other files in the UDF file system not in the DICOM File-set, may use characters beyond those defined by DICOM for File ID Components, including those encoded in 16 bits.

4. The character set for File IDs and File-set IDs (see PS 3.10) is a subset of the ISO 9660 character set, therefore no further restrictions need to be imposed for ISO 9660 filesystems.

X.1.2 DICOM File-set

One and only one DICOM File-set shall be stored on each side of a single piece of media.

A DICOM File-set is defined to be completely contained within one UDF or ISO 9660 File-set.

Only a single UDF or ISO 9660 File-set shall be present in the UDF Volume.

Each side of the media will comprise a single self-contained UDF or ISO 9660 Volume. That is the UDF or ISO 9660 Volume Set shall not consist of more than one UDF or ISO 9660 Volume.

Only a single UDF or ISO 9660 Partition shall be present on each side the media.

Note: Other partitions containing other file systems, possibly sharing the same data, may be present, such as an ISO-9660 bridge disk, a Mac HFS or Unix UFS hybrid disk, etc.

X.1.3 DICOM File ID Mapping

The UDF and ISO 9660 Standards provide a hierarchical structure for directories and files within directories. Each volume has a root directory that may contain references to both files and subdirectories. Subdirectories may contain reference to both files and other subdirectories.

X.1.3.1 File ID

PS 3.10 defines a DICOM File ID Component as a string of 8 characters from a subset of the G0 repertoire of ISO 8859. Each of these File ID Components is mapped to a UDF File Identifier or Path Component in the OSTA CS0 character set.

Note: This mapping is a subset of the MS-DOS mapping specified in UDF.

Filename extensions are not used in DICOM File ID Components, hence an UDF or ISO 9660 File Identifier shall not contain a File Extension or the '.' that would precede such a File Extension.

The maximum number of levels of a Resolved Pathname in a UDF or ISO 9660 file-set shall be at most 8 levels, to comply with the definition of a DICOM File-set in PS 3.10.

The File Version Number is always equal to 1, as specified by UDF or ISO 9660.

Note: This file ID mapping is also compatible with ISO 9660 Level 1.

X.1.3.2 DICOMDIR File

A DICOMDIR file in a DICOM File-set shall reside in the root directory of the directory hierarchy, as specified in PS 3.10.

X.1.4 DICOM File Management Information

No file management information beyond that specified in the UDF or ISO 9660 File Entry is required. In particular no Extended Attributes or Named Streams are required.

Note: Unlike the Annex of this part specifying CD-R media, no restrictions or specifications with respect to ISO 9660 Recording Date and Time, file modification date, file owner identification and permissions, or other Extended Attribute Record values are specified, since these may be beyond the control of the DICOM application.

X.2 FILESYSTEM

The reader shall be able to read a logical format conforming to UDF and ISO 9660 filesystems, as defined below.

The creator shall be able to create a logical format conforming to UDF or ISO 9660 filesystems or both, as defined below.

No requirements are defined for an updater.

Note: The intent of these requirements is to insist that a reader be able to read media created by any creator, but not to require that media created by a particular creator can necessarily be updated by a different updater.

X.2.1 UDF File system

The reader shall be able to read a logical format conforming to UDF 1.02 or 1.5 or 2.0 or 2.01, as required by the UDF 2.01 standard.

The creator shall be able to create a logical format conforming to any one of UDF 1.02 or 1.5 or 2.0 or 2.01.

Options or extensions defined in UDF are required or restricted as specified in the following sub-sections, and in the media specific sub-sections.

Note: Though the names of the files within the DICOM Fileset are restricted by PS 3.10, other files on the media may have longer filenames.

X.2.1.1 Interchange Levels

For the UDF Primary Volume Descriptor, both the Interchange Level and Maximum Interchange Level shall always be set to 2.

Notes: 1. This means that the volume is not and will never be, part of a multi-volume set.

2. The Interchange Level and Maximum Interchange Level in the File Set Descriptor are defined by UDF to always be 3. This is despite the fact that restrictions specified for the DICOM File-set may be very similar to lower Interchange Levels specified in ECMA 167.

X.2.1.2 Virtual Partition Map and Allocation Tables

Creators and updaters may or may not write UDF Virtual Partition Maps and Virtual Allocation Tables depending on the appropriate choice for physical media.

All readers are required to support UDF Virtual Partition Maps and Virtual Allocation Tables.

X.2.1.3 Sparable Partition Maps and Sparing Tables

Creators and updaters may or may not write UDF Sparable Partition Maps and Sparing Tables depending on the appropriate choice for physical media, since defect management may or may not be performed in the drive.

All readers are required to support UDF Sparable Partition Maps and Sparing Tables.

X.2.1.4 System Dependent Requirements

The reader shall not depend on any system dependent requirements as specified in UDF to be able to read the DICOM File-set, and shall not behave differently if they are present. Any unrecognized system dependent requirements shall be gracefully ignored.

Creators and updaters writing to a version of UDF that supports Named Streams shall use the default stream to write each file within the DICOM File-set.

Notes: 1. For example, a particular form of file permissions, particular extended attributes or particular named streams may not be required or affect application behavior.

2. This does not mean that Extended Attributes or Named Streams may not be present and associated with files within the DICOM File-set.

X.2.1.5 Permissions and File Characteristics

Creators and updaters shall always create permissions for files within the DICOM File Set such that all users may read, write and delete all files, and all users may access and delete all directories on all systems.

Notes: 1. These requirements are equivalent to setting a Unix permission of 644 for files and 755 for directories.

2. The intent of these requirements is that for DICOM interchange media, implementation specific access control is not used or required.

The UDF File Identifier Descriptor for files within the DICOM File Set shall not specify a File Characteristic of "hidden."

X.2.1.6 File Types

The UDF File Types within the DICOM File Set shall only be files (that is a File Type of 0, meaning unspecified interpretation) or symbolic links to files (that is a File Type of 12).

X.2.2 ISO 9660 File system

The reader shall be able to read a logical format conforming to ISO 9660 Level 1, 2 and 3, with or without Rockridge or Joliet Extensions, which may or may not be present.

The creator shall be able to create a logical format conforming to ISO 9660 Level 1, 2 or 3, and may or may not add Rockridge or Joliet Extensions.

Note: Though the files within the DICOM Fileset are restricted to names that conform to a subset of ISO 9660 Level 1, other files on the media may have longer filenames. Unlike the Annex of this part specifying CD-R media, strict Level 1 conformance of the filesystem is not required, since this has proven difficult to constrain in practice.

X.2.2.1 Extended Attributes, Permissions and File Characteristics

File modification data, file owner identification, and permissions are part of the ISO 9660 - Extended Attribute Record. Support of the Extended Attribute Record is not required.

If Extended Attribute Records are present, all files within the DICOM File Set shall have permissions such that all users may read all files, and all users may access all directories on all systems.

Note: The intent of these requirements is that for DICOM interchange media, implementation specific access control is not used or required.

X.3 MEDIA FORMATS

X.3.1 DVD

X.3.1.1 DVD Physical Format

The physical format of DVD media shall comply with one of the following applicable definitions:

- DVD Specifications for Recordable Disc (DVD-R for General): Part 1 - Physical Specifications Version 2.0
- DVD Specifications for Recordable Disc (DVD-R for Authoring): Part 1 - Physical Specifications Version 2.0
- DVD Specifications for Read-Only Disc (DVD-ROM): Part 1 - Physical Specifications Version 1.13
- DVD Specifications for Re-Recordable (DVD-RW): Part 1 - Physical Specifications Version 1.1
- DVD+RW Physical Specifications, Version 1.1
- DVD+R Physical Specifications, Version 1.1

X.3.1.1.1 DVD Sector Format

The sector format of DVD media shall comply with one of the following applicable definitions:

- DVD Specifications for Recordable Disc (DVD-R for General): Part 2 - File System Specifications Version 2.0
- DVD Specifications for Recordable Disc (DVD-R for Authoring): Part 2 - File System Specifications Version 2.0
- DVD Specifications for Read-Only Disc (DVD-ROM): Part 2 - File System Specifications Version 1.13
- DVD Specifications for Re-Recordable Disc (DVD-RW): Part 2 – File System Specifications Version 1.0
- DVD+RW Defect Management & Physical Formatting Specification, Version 1.0

No restrictions are placed on the use of disc-at-once, track-at-once, multi-session or packet-written format if applicable to the physical media type, other than that any session should be finalized at the conclusion of writing the media in order to make it readable.

X.3.1.2 DVD Logical Format

There are no requirements, restrictions, options or extensions to the logical format that are specific to this media type, beyond those specified in section X.2.

X.3.1.3 DVD Physical Media

The physical medium shall be the 120 mm DVD-R medium as defined in one of the following:

- DVD Specifications for Recordable Disc (DVD-R for General): Part 1 - Physical Specifications Version 2.0
- DVD Specifications for Recordable Disc (DVD-R for Authoring): Part 1 - Physical Specifications Version 2.0
- DVD Specifications for Read-Only Disc (DVD-ROM): Part 1 - Physical Specifications Version 1.13
- DVD Specifications for Re-Recordable (DVD-RW): Part 1 - Physical Specifications Version 1.1
- DVD+RW Physical Specifications, Version 1.1
- DVD+R Physical Specifications, Version 1.1