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Digital Imaging and Communications in Medicine (DICOM)

6

7 *Supplement 40: DVD-RAM Media Application Profiles*

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24 **DICOM Standards Committee, Working Group 5 Interchange Media**

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Contents

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Foreword

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74 This Supplement has been prepared by the DICOM Working Group 5 (Interchange Media) according
75 to the procedures of the DICOM Committee.

76 The DICOM Standard is structured as a multi-part document using the guidelines established in the
77 following document:

78   - ISO/IEC Directives, 1989 Part 3 : Drafting and Presentation of International Standards.

79 This document is a Supplement to the DICOM Standard. It is an extension to PS 3.11 and 3.12 of
80 the published DICOM Standard which consists of the following parts:

PS 3.1	-	Introduction and Overview
PS 3.2	-	Conformance
PS 3.3	-	Information Object Definitions
PS 3.4	-	Service Class Specifications
PS 3.5	-	Data Structures and Encoding
PS 3.6	-	Data Dictionary
PS 3.7	-	Message Exchange
PS 3.8	-	Network Communication Support for Message Exchange
PS 3.9	-	Point-to-Point Communication Support for Message Exchange
PS 3.10	-	Media Storage and File Format for Data Interchange
PS 3.11	-	Media Storage Application Profiles
PS 3.12	-	Media Formats and Physical Media for Data Interchange
PS 3.13	-	Print Management Point-to-Point Communication Support
PS 3.14	-	Grayscale Standard Display Function
PS 3.15	-	Security Profiles
PS 3.16	-	Content Mapping Resource

97 These parts are related but independent documents.

98   **Scope and Field of Application**

99   New clinical applications have requirements for higher capacity media formats that are becoming
100   available that can potentially be used for image interchange. These include the DVD based
101   rewritable DVD_RAM media format that is addressed by this supplement.

102   **CHOICE OF A FILESYSTEM**

103   The existing DICOM media make use either of the DOS FAT16 file system, or in the case of CD-R,
104   the ISO 9660 Level 1 file system.

105   The FAT16 file system is limited in the number of clusters (minimum unit of disk space that can be
106   allocated) that it can address in a single partition to 2^{16}-1. This results in very large clusters and
107   wastage of large amounts of space as the size of the media increases.

108   The ISO 9660 file system is only used on CD-ROM, and CD-R media, and is not suitable for frequent
109   incremental updates, since its allocation table is in a fixed location at the beginning of a track.

110   Therefore, a new file system is required to make efficient use of higher capacity media writable and
111   rewritable media. The consumer and computer industries have standardized on UDF, a profile of
112   ECMA 167/ISO 13346, for DVD media.

113   CD-R media is normally written "disk at once" or "track at once" (effectively requiring the entire
114   volume to be cached on a hard disk in advance). The medical imaging industry has been reluctant to
115   use multi-session recording which not only wastes space (due to large lead-in and lead-out areas)
116   but also is perceived to risk destruction of the existing content of the CD-R.

117   Caching an entire volume of data for the new higher capacity media is undesirable and potentially
118   unnecessary if incrementally or randomly writable media is used. Accordingly, the choice of at least
119   UDF version 1.5 rather than 1.02 (used by DVD-Video players) is required. This strategy is consistent
120   with the consumer and IT industry providers who are using UDF 1.5 for so-called "drive letter" write
121   access to new types of media.

122   Named Streams that are added in UDF 2.0 allow the feature of the same name in Windows NT to be
123   copied to UDF file systems, in addition to being a more flexible approach to storing other OS specific
124   features (such as Mac finder information and resource forks) that are stored as Extended Attributes
125   in earlier UDF versions. The named streams also provide a place to encode media specific
126   information such as laser power calibration parameters (not needed for DVD-RAM).

127   For the purposes of this supplement, UDF 1.5 has been selected, since that is the only version
128   currently implemented by operating system, software and driver vendors, UDF 2.0x is still undergoing
129   revision, and none of the Named Streams features are directly relevant to the DICOM application.

130   **CHOICE OF A PHYSICAL MEDIUM**

131   The choice of a file system such as UDF provides a means of supporting new media types in a
132   robust manner, but is only a step towards interoperability of removable media.

133   It should be stressed that DICOM is not attempting to standardize an archive medium, only an
134   interchange medium. Though many applications typically write interchange media using the same
135   physical drive and software as is used for writing single archival volumes for shelf management, there
136   is no requirement that the media defined here be of archival longevity. Furthermore, in a large
137   automated archive that maintains multiple platters, there is no suggestion that DICOM media is
138   appropriate or optimized for that application. Indeed, proprietary disk or tape based formats may well
139   be more suitable, since the proposed media, file system and DICOMDIR structure are not optimized
140   for such applications.

141   The input of other working groups that may use new media has been sought. The ultrasound
142   working group places a high priority on rewritability and is interested in an "MOD" replacement. The

143   cardiac group places a high priority on the ability to read any new medium on a physician's desktop
144   PC without additional hardware, making readability on conventional DVD-ROM drives essential.

145   Taking into account the suggestions of the various groups, it is apparent that no single choice of
146   DVD-based media will satisfy the unique requirements of every application. Accordingly, specific
147   types of DVD media will be added to the standard as the need arises and as the technology
148   becomes available from multiple media and drive vendors.

149   At the present time, 4.7GB per-side DVD-RAM media and drives are available and satisfy the needs
150   of multiple groups. Accordingly, profiles are defined for General Purpose (uncompressed), Ultrasound
151   and CT/MR applications. It is expected that in the future Cardiac profiles will be added that make use
152   of another DVD media type, such as DVD-R.

153   **FORM OF THIS SUPPLEMENT**

154   This supplement defines the use of DVD-RAM physical media.

155   It specifies the use of the Universal Disk Format (UDF) 1.5.

156   Media Application Profiles are defined for general purpose and clinically specific applications,
157   including general purpose, ultrasound and CT/MR.

158   Since this document proposes changes to existing Parts of DICOM, the reader should have a
159   working understanding of the Standard. This proposed Supplement includes a number of Addenda
160   to existing Parts of DICOM:

161   - PS 3.11 Addendum: Media Storage Application Profiles

162   - PS 3.12 Addendum: Media Formats and Physical Media

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171 **Changes to**

172 **NEMA Standards Publication PS 3.11-2000**

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174 *Digital Imaging and Communications in Medicine (DICOM)*

175 *Part 11: Media Storage Application Profiles*

176 **2 Normative References**

177 **3 Definitions**

178 **4 Symbols and abbreviations**

179 **DVD** A trademark of the DVD Forum that is not an abbreviation.

180 **UDF** Universal Disk Format

181 **Annex C**   **Ultrasound Application Profile**
182 **(Normative)**

183 **C.1 CLASS AND PROFILE IDENTIFICATION**

184 This Annex defines Application Profiles for Ultrasound Media Storage applications. Each Application
185 Profile has a unique identifier used for conformance claims. Due to the variety of clinical applications
186 of storage media in Ultrasound, a family of application profiles are described in this section to best
187 tailor an application choice to the specific needs of the user. The identifier used to describe each
188 profile is broken down into three parts: a prefix, mid-section, and suffix. The prefix describes the
189 overall Application Profile Class and is common for all ultrasound application profiles. The mid section
190 describes the specific clinical application of the profile. The suffix is used to describe the actual media
191 choice the profile will use.

192 The prefix for this class of application profiles is identified with the STD-US identifier.

193 Note: Conformance Statements may use the earlier prefix of APL which is equivalent to STD. This use is
194 deprecated and may be retired in future versions of the standard.
195

196 The midsection is broken down into three subclasses which describes the clinical use of the data.
197 These classes are: Image Display (ID identifier), Spatial Calibration (SC identifier), and Combined
198 Calibration (CC identifier). All three subclasses can be applied to either single frames (SF) images or
199 single and multi-frames (MF) images. The SC subclass enhances the ID class by adding the
200 requirement for region specific spatial calibration data with each IOD. The CC subclass enhances the
201 SC subclass by requiring region specific pixel component calibration.

202 The suffix, xxxx, is used to describe the actual media choice used for the conformance claim. Any of
203 the above mentioned classes can be stored onto one of eight pieces of media described in the
204 Table C.3-3.

205 The specific Application Profiles are shown in the following table.

206 **Table C.1-1**
207 **APPLICATION PROFILE IDENTIFIERS**

Application Profile	Single Frame	Single & Multi-Frame
Image Display	STD-US-ID-SF-xxxx	STD-US-ID-MF-xxxx
Spatial Calibration	STD-US-SC-SF-xxxx	STD-US-SC-MF-xxxx
Combined Calibration	STD-US-CC-SF-xxxx	STD-US-CC-MF-xxxx

208

209 The ID Application Profile Classes are intended to be used for the transfer of ultrasound images for
210 display purposes.

211 The SC Application Profile Classes are intended to be used for the transfer of ultrasound images with
212 spatial calibration data for quantitative purposes (see section C.4).

213 The CC Application Profile Classes are intended to be used for the transfer of ultrasound images with
214 spatial and pixel component calibration data for more advanced quantitative purposes (see section
215 C.5).

216 **C.2 CLINICAL CONTEXT**

217 ...

218 **C.2.1   Roles**

219 **C.2.1.1FILE SET CREATOR**

220 The role of File Set Creator shall be used by Application Entities which generate a File Set under the
221 STD-US class of Application Profiles. Typical entities using this role would include ultrasound imaging
222 equipment, workstations, and archive systems which generate a patient record for transfer. File Set
223 Creators shall be able to generate the DICOMDIR directory file, single and/or multi frame Ultrasound
224 Information Object files, and depending on the subclass, region specific calibration in the defined
225 Transfer Syntaxes.

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

230 **C.2.1.2FILE SET READER**

231 The role of File Set Reader shall be used by Application Entities which receive a transferred File Set.
232 Typical entities using this role would include ultrasound systems, display workstations, and archive
233 systems which receive a patient record from a piece of media. File Set Readers shall be able to read
234 the DICOMDIR directory file and all Information Objects defined for the specific Application Profiles,
235 using the defined Transfer Syntaxes.

236 **C.2.1.3FILE SET ~~USER~~ UPDATER**

237 The role of File Set Updater shall be used by Application Entities which receive a transferred File Set
238 and updates it by the addition or deletion of objects to the media. Typical entities using this role
239 would include ultrasound systems adding new patient records to the media and workstations which
240 may add an information object containing a processed or modified image.

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

245 **C.3GENERAL CLASS PROFILE**

246 ...

247 **C.3.2   Physical Media And Media Formats**

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

250
251

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**

252

253   ...

254   **Annex D (Normative) - General Purpose CD-R and <u>DVD</u> ~~Image~~ Interchange Profile<u>s</u>**

255   D.1 PROFILE IDENTIFICATION

256   This Annex defines an Application Profile Class potentially inclusive of all defined Media Storage
257   SOP Classes. This class is intended to be used for the interchange of Composite **~~Image and~~**
258   **~~Standalone~~** SOP Instances via CD-R **and DVD-RAM** media for general purpose applications. Objects
259   from multiple modalities may be included on the same media.

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

261   **Table D.1-1 STD-GEN-~~CD~~ Profile<u>s</u>**

Application Profile	Identifier	Description
General Purpose CD-R ~~Image~~ Interchange	STD-GEN-CD	Handles interchange of Composite **~~Image~~** SOP Instances **~~and SOP Instances which conform to the model defined for Stand-alone SOP Classes,~~** such as **Images, Structured Reports, Presentation States and Waveforms, ~~Curves, Overlays and LUTs~~**.
General Purpose Interchange on DVD-RAM Media	**STD-GEN-DVD-RAM**	**Handles interchange of Composite SOP Instances such as Images, Structured Reports, Presentation States and Waveforms.**

262

263   The identifier for this General Purpose Image Exchange profile **class** shall be STD-GEN-~~CD~~.

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

266   Note: Since it is not required to support all Media Storage Classes the user should carefully consider the
267   subset of supported Media Storage SOP Classes in the Conformance Statements of such equipment
268   to establish effective object interchange.
269

270   D.2 CLINICAL CONTEXT

271   This Application Profile facilitates the interchange of images and related data on CD-R **and DVD-**
272   **RAM** media. Typical interchange would be between acquisition devices, archives and workstations.

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

275   This profile is intended only for general purpose applications. It is not intended as a replacement for
276   specific Application Profiles that may be defined for a particular clinical context. The latter may
277   support compression transfer syntaxes, limitations on the form and content of SOP Class instances,
278   and specific media choices that preclude the use of the General Purpose Interchange Profile.

279   Note: The creation of a CD~~-R~~ **or DVD-RAM** is considerably more complex than the reading thereof. Therefore
280   the clinical context for this Application profile is likely to be asymmetric, with a sophisticated File Set
281   Creator and relatively simple File Set Readers.
282

283 **D.2.1 Roles and Service Class Options**

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

286 The Application Entity shall support one or more of the roles of File Set Creator (FSC), File Set
287 Reader (FSR), and File Set Updater (FSU), defined in PS 3.10.

288 D.2.1.1 File Set Creator

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

291 File Set Creators shall be able to generate the Basic Directory SOP Class in the DICOMDIR file with
292 all the subsidiary Directory Records related to the Image SOP Classes stored in the File Set.
293 The Application Entity acting as a File Set Creator generates a File Set under ~~the~~ **a** STD-GEN~~-CD~~
294 Application Profile.

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

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

305

306 D.2.1.2 File Set Reader

307 The role of File Set Reader shall be used by Application Entities which receive a transferred File Set
308 under the Image Interchange Class of Application Profiles. Typical entities using this role would
309 include image generating systems, display workstations, and archive systems which receive a patient
310 record; e.g. transferred from another institution.

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

314 D.2.1.3 File Set Updater

315 The role of File Set Updater is used by Application Entities which receive a transferred File Set under
316 the Image Exchange Class of Application Profiles and update it by the addition (or deletion) of
317 images or information to (or from) the medium. Typical entities using this role would include image
318 generating systems and workstations which process or modify images.

319 File Set Updaters shall be able to generate one or more of the SOP Instances defined for this
320 Application Profile, for which a Conformance Statement is made, and to read and update the
321 DICOMDIR file.

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

326   Note: If the volume has not been finalized, the File Set Updater will be able to update information assuming
327   there is enough space on the volume to write a new DICOMDIR file, the information, and the
328   fundamental volume control structures. Volume control structures are the structures that are inherent to
329   the standards of the physical volume, see PS 3.12.

330

331   D.3 STD-GEN ~~CD~~ PROFILE **<u>CLASS</u>**

332   ...

333   **D.3.2 Physical Medium And Medium Format**

334   The STD-GEN-CD application profile requires the 120 mm CD-R physical medium with the ISO/IEC
335   9660 Media Format, as defined in PS3.12.

336   **<u>The STD-GEN-DVD-RAM application profile requires the 120 mm DVD-RAM medium, as defined</u>**
337   **<u>in PS 3.12.</u>**

338   **Annex E (Normative) - CT and MR Image Application Profiles**

339   E.1 PROFILE IDENTIFICATION

340   This Annex defines Application Profiles for Computed Tomography and Magnetic Resonance
341   Imaging interchange and storage on high capacity rewritable magneto-optical disks (MOD), CD-R,
342   **and DVD-RAM** with lossless compression.

343   **Table E.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.
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.**

344

345   E.2 CLINICAL CONTEXT

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

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

351   **E.2.1 Roles and Service Class Options**

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

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

356 ## E.2.1.1 File Set Creator

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

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

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

372

373 ## E.2.1.2 File Set Reader

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

379 ## E.2.1.3 File Set Updater

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

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

391 ~~Note: The File-set Updater shall be able to update information assuming there is enough space on~~
392 ~~the volume to write a new DICOMDIR file and the information.~~
393 Note: **If the volume has not been finalized, the File Set Updater will be able to update information**
394   **assuming there is enough space on the volume to write a new DICOMDIR file, the information,**
395   **and the fundamental volume control structures. Volume control structures are the structures that**
396   **are inherent to the standards of the physical volume, see PS 3.12.**

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398

399 **E.3 STD-CTMR PROFILES**

400 **E.3.2 Physical Medium And Medium Format**

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

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

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

407 The STD-CTMR-CD application profile requires the 120 mm CD-R physical medium with the ISO
408 9660 Media Format, as defined in PS 3.12.

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

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419 **Changes to**

420 **NEMA Standards Publication PS 3.12-2000**

421

422 *Digital Imaging and Communications in Medicine (DICOM)*

423 *Part 12: Media Formats and Physical Media for Media Interchange*

424

425 # 2   Normative references

426 ISO 9660: 1988 (E) Information processing - Volume and file structure of CD ROM for
427   information interchange

428 ISO/IEC 10149 Information technology - Data interchange on read-only optical discs (CD-
429   ROM), 1989

430 Part II: CD-WO version 2.0 in Orange Book

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

432 System Description CD-ROM XA (eXtended Architecture) Specification

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

434

435 **OSTA Universal Disk Format Specification (UDF) Version 1.5. February 4, 1997.**

436 **ISO/IEC 13346:1995 - Volume and file structure of write-once and rewritable media using**
437   **non-sequential recording for information interchange.**

438 **ECMA 167 3rd Edition June 1997 - Volume and file structure of write-once and rewritable**
439   **media using non-sequential recording for information interchange.**

440 **Unicode Standard, Version 2.0 (ISBN 0-201-48345-9) Addison-Wesley.**

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

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

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

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

449

450 # 3   Definitions

451 # 4   Symbols and abbreviations

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

453 **CD   Compact Disk**

454 **CD-R**   Compact Disc – Recordable

455 **CD-ROM   Compact Disk - Read Only**

456 **CD-RW   Compact Disk - Rewritable**

457 **CD-WO**   Compact Disc – Write Once

458   **DVD   A trademark of the DVD Forum that is not an abbreviation**

459   **DVD-RAM   DVD-Random Access**

460   **OSTA   Optical Storage Technology Association**

461   **UDF   Universal Disk Format**

462

463

464 **Annex J   UDF on 120 mm DVD-RAM Medium (Normative)**

465   This Annex defines the use of the UDF 1.5 file system with DVD-RAM media.

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

468   2. DVD-ROM is a pre-mastered medium, that is it is manufactured rather than written on a one-off basis
469   by a medical device. While it is likely that a device conforming to this Annex will be able to read a UDF
470   file system from DVD-ROM, it is not a requirement.

471

472   Universal Disk Format (UDF) version 1.5 is a profile of the ECMA 167 3rd edition file system.

473   Notes: 1. The ECMA 167 3rd edition is more recent than ISO 13346:1995 which is equivalent to ECMA 167
474   2nd edition.

475   2. Though later revisions of UDF such as 2.0 are defined with additional features compared to 1.5,
476   these features are not required to support recording of a DICOM file set.

477   3. A reader of a UDF 2.0 file system can also read a 1.5 or 1.02 file system.

478   4. A UDF 1.02 reader cannot read the Virtual Allocation Table (VAT) used to incrementally write a UDF
479   1.5 or later disk.

480   5. A UDF 1.5 file system reader can theoretically read those structures of a UDF 2.0 file system that are
481   common to both versions. However, a UDF 1.5 reader cannot read the Named Streams or extended
482   file entries that may be recorded on a UDF 2.0 file system.

483   Since a UDF 1.5 reader may completely reject a 2.0 disk based on the version number written on the
484   media, without attempting to read compatible structures of the file system, it is not permitted to write
485   DICOM media with a version greater than 1.5.

486   6. A writer (FSC or FSU) is not permitted to add structures from a later version of UDF to a file system
487   that has been created with an earlier version of the file system.

488

489   **J.1 DICOM MAPPING TO MEDIA FORMAT**

490   **J.1.1   Media Character Set**

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

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

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

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

500

501   **J.1.2   DICOM File-set**

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

503   A DICOM File-set is defined to be completely contained within one UDF File-set.

504   Only a single UDF File-set shall be present in the UDF Volume.

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

507   Only a single UDF Partition shall be present on each side the media.

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

510

511

512 J.1.3 DICOM File ID Mapping

513 The UDF Standard provides a hierarchical structure for directories and files within directories. Each
514 volume has a root directory that may contain references to both files and subdirectories.
515 Subdirectories may contain reference to both files and other subdirectories.

516 J.1.3.1 File ID

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

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

521

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

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

526 The File Version Number is always equal to 1, as specified by UDF.

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

528

529 J.1.3.2 DICOMDIR File

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

532 J.1.4 DICOM File Management Information

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

535 J.2 FILESYSTEM

536 J.2.1 UDF File system

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

539 The creator shall be able to create a logical format conforming to UDF 1.5.

540 The updater shall be able to update a logical format conforming to UDF 1.02 or 1.5, without updating
541 the UDF revision level of the file system already recorded on the media, as required by the UDF 1.5
542 standard.

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

545 J.2.1.1 Interchange Levels

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

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

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

552

553 J.2.1.2 Virtual Partition Map and Allocation Tables

554 Creators and updaters shall not write UDF Virtual Partition Maps and Virtual Allocation Tables on
555 DVD-RAM media.

556 J.2.1.3 Sparable Partition Maps and Sparing Tables

557 Creators and updaters shall not write UDF Sparable Partition Maps and Sparing Tables on DVD-RAM
558 media, since defect management is performed in the drive.

559 J.2.1.4 System Dependent Requirements

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

563   Notes: 1. For example, a particular form of file permissions, particular extended attributes or particular named
564   streams may not be required or affect application behavior.
565   2. This does not mean that Extended Attributes or Named Streams may not be present and associated
566   with files within the DICOM File-set.

567

568 J.2.1.5 Permissions and File Characteristics

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

572   Notes: 1. These requirements are equivalent to setting a Unix permission of 644 for files and 755 for
573   directories.
574   2. The intent of these requirements is that for DICOM interchange media, implementation specific
575   access control is not used or required.

576

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

579 J.2.1.6 File Types

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

582 J.3 MEDIA FORMATS

583 J.3.1   DVD-RAM

584 J.3.1.1 DVD- RAM Physical Format

585 The physical format of DVD-RAM media shall comply with the applicable definitions within "DVD
586 Specifications for Rewritable Disc (DVD-RAM 4.7GB): Part 1 - Physical Specifications Version 2.0"
587 with the additional modifications described in the following sub-sections.

588   Note: Two physical forms of DVD-RAM are available, a double-sided variety (Type 1), and a single-sided
589   variety (Type 2). Only Type 2 media can be removed from its cartridge and inserted in a conventional
590   DVD-ROM drive.

591

592 J.3.1.1.1   DVD- RAM Sector Format

593 The sector format of DVD-RAM media shall comply with the applicable definitions in "DVD
594 Specifications for Rewritable Disc (DVD-RAM 4.7GB): Part 2 - File System Specifications Version 2.0".

595 DVD-RAM is a truly random access media, providing random access to fixed length sectors, hence
596 no multi-session or packet-written format is applicable.

597 **J.3.1.2 DVD- RAM Logical Format**

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

600 **J.3.1.3 DVD- RAM Physical Media**

601 The physical medium shall be the 120 mm DVD-RAM medium as defined in "DVD Specifications for
602 Rewritable Disc (DVD-RAM 4.7GB): Part 1 - Physical Specifications Version 2.0".