

Digital Imaging and Communications in Medicine (DICOM)

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Přehled I

Úvod

Jak to vypadá?
Co je DICOM?

DICOM Standard

Obecně
Objekty, Elementy, Tagy
Datový model
Information Object Definition, IOD

Secondary Capture Image

Přehled atributů
Metainformace v souboru

Závěr

Praktická ukázka

Přehled II

Otázky ke zkoušce

Otázky ke zkoušce

DICOM Hexdump

```
00000000 52 75 62 6f 20 44 49 43 4f 4d 20 56 69 65 77 65 |Rubo DICOM View|
00000010 72 20 64 65 6d 6f 2e 20 57 57 57 2e 52 55 42 4f |r demo. WWW.RUBO|
00000020 4d 45 44 2e 43 4f 4d 00 00 00 00 00 00 00 00 |MED.COM.....|
00000030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 |.....|
*
00000080 44 49 43 4d 02 00 00 00 55 4c 04 00 a6 00 00 00 |DICM....UL.....|
00000090 02 00 01 00 4f 42 00 00 02 00 00 00 00 01 02 00 |...OB.....|
000000a0 02 00 55 49 1a 00 31 2e 32 2e 38 34 30 2e 31 30 |..UI..1.2.840.10|
000000b0 30 30 38 2e 35 2e 31 2e 34 2e 31 2e 31 2e 34 00 |008.5.1.4.1.1.4.|
000000c0 02 00 03 00 55 49 26 00 31 2e 33 2e 34 36 2e 36 |...UI&.1.3.46.6|
000000d0 37 30 35 38 39 2e 31 31 2e 30 2e 34 2e 31 39 39 |70589.11.0.4.199|
000000e0 36 30 38 32 33 30 37 33 38 30 30 30 36 00 02 00 |6082307380006...|
000000f0 10 00 55 49 14 00 31 2e 32 2e 38 34 30 2e 31 30 |..UI..1.2.840.10|
00000100 30 30 38 2e 31 2e 32 2e 31 00 02 00 12 00 55 49 |008.1.2.1....UI|
00000110 10 00 31 2e 33 2e 34 36 2e 36 37 30 35 38 39 2e |..1.3.46.670589.|
00000120 31 37 02 00 13 00 53 48 0c 00 41 52 43 5f 43 4f |17....SH..ARC_CO|
00000130 4e 56 45 52 54 20 08 00 05 00 43 53 0a 00 49 53 |NVERT ....CS..IS|
00000140 4f 5f 49 52 20 31 30 30 08 00 08 00 43 53 1c 00 |O_IR 100....CS..|
00000150 4f 52 49 47 49 4e 41 4c 5c 50 52 49 4d 41 52 59 |ORIGINAL\PRIMARY|
00000160 5c 4f 54 48 45 52 5c 52 5c 49 52 20 08 00 12 00 |\OTHER\R\IR ....|
00000170 44 41 08 00 31 39 39 36 30 38 32 33 08 00 13 00 |DA..19960823....|
00000180 54 4d 06 00 30 39 33 38 30 31 08 00 14 00 55 49 |TM..093801....UI|
00000190 14 00 31 2e 33 2e 34 36 2e 36 37 30 35 38 39 2e |..1.3.46.670589.|
000001a0 31 31 2e 30 2e 35 08 00 16 00 55 49 1a 00 31 2e |11.0.5....UI..1.|
000001b0 32 2e 38 34 30 2e 31 30 30 30 38 2e 35 2e 31 2e |2.840.10008.5.1.|
000001c0 34 2e 31 2e 31 2e 34 00 08 00 18 00 55 49 26 00 |4.1.1.4....UI&.|
000001d0 31 2e 33 2e 34 36 2e 36 37 30 35 38 39 2e 31 31 |1.3.46.670589.11|
```

Příklad zobrazení



Obrázek: DICOM Ukázka zobrazení

Příklad zobrazení

```
# Dicom-Data-Set
# Used TransferSyntax: UnknownTransferSyntax
(0008,0016) UI =SecondaryCaptureImageStorage # 26, 1 SOPClassUID
(0028,0002) US 3 # 2, 1 SamplesPerPixel
(0028,0004) CS [YBR_FULL_422] # 12, 1 PhotometricInterpretation
(0028,0006) US 0 # 2, 1 PlanarConfiguration
(0028,0010) US 96 # 2, 1 Rows
(0028,0011) US 372 # 2, 1 Columns
(0028,0100) US 8 # 2, 1 BitsAllocated
TAG(028,0101) US 8 # 2, 1 BitsStored
(0028,0102) US 7 # 2, 1 HighBit
(0028,0103) VM US 0 # 2, 1 PixelRepresentation
(0028,2110) Value[01] # 2, 1 Value Length eCompres Value Multiplicity (VM)
(0028,2114) CS [ISO_10918_1] # 12, 1 LossyImageCompressionMethod
(7fe0,0010) OB (PixelSequence #=2) # u/1, 1 PixelData
(fffe,e000) pi (no value available) # 0, 1 Item
(fffe,e000) pi
ff\d8\xff\db\00\43\00\08\06\06\07\06\05\08\07\07\07\09\09\08\0a\0c... # 9624, 1
Item
(fffe,e0dd) na (SequenceDelimitationItem) # 0, 0 SequenceDelimitationItem
```

Obrázek: DICOM Ukázka textového přepisu

DICOM Hexdump

```
(0x0002,0x0000) UL File Meta Information Group Length   VR=<UL>   VL=<0x0004> [0x000000a6]
(0x0002,0x0001) OB File Meta Information Version       VR=<OB>   VL=<0x0002> [0x00,0x01]
(0x0002,0x0002) UI Media Storage SOP Class UID        VR=<UI>   VL=<0x001a> <1.2.840.10008.5.1.4.
(0x0002,0x0003) UI Media Storage SOP Instance UID     VR=<UI>   VL=<0x0026> <1.3.46.67058
(0x0002,0x0010) UI Transfer Syntax UID                VR=<UI>   VL=<0x0014> <1.2.840.10008.1.2.1>
(0x0002,0x0012) UI Implementation Class UID          VR=<UI>   VL=<0x0010> <1.3.46.670589.17>
(0x0002,0x0013) SH Implementation Version Name       VR=<SH>   VL=<0x000c> <ARC_CONVERT >
(0x0008,0x0005) CS Specific Character Set             VR=<CS>   VL=<0x000a> <ISO_IR 100>
(0x0008,0x0008) CS Image Type                        VR=<CS>   VL=<0x001c> <ORIGINAL\PRIMARY\OTHER\R\IR >

...
(0x0010,0x0010) PN Patient's Name                    VR=<PN>   VL=<0x0014> <MR/BRAIN/GRASE/1024 >
(0x0010,0x0020) LO Patient ID                         VR=<LO>   VL=<0x0002> <7 >
(0x0010,0x0030) DA Patient's Birth Date              VR=<DA>   VL=<0x0008> <19010101>

...
(0x7fe0,0x0010) OX Pixel Data                        VR=<OW>   VL=<0x80000> [] # skipping ...
```

Dicom je

- ▶ *Formát souboru* (vč. informací pacienta, acquisition data, kontext studie – pro spojení s příslušným ošetřením)
- ▶ *Síťový protokol* (výměna informací, zejm. obrázků).
- ▶ Zejména však *definice rozhraní* – důležité pro integraci výrobci zařízení. Zařízení mohou poskytovat i pořizovat (zobrazit) data z jiných zařízení.
- ▶ Pomocí specifikace IOD (Information Object Definition) si aplikace mohou vyměňovat virtuální objekty bez nutnosti znalosti aplikace na druhé straně (a znalosti tamější interní reprezentace).

Dicom je

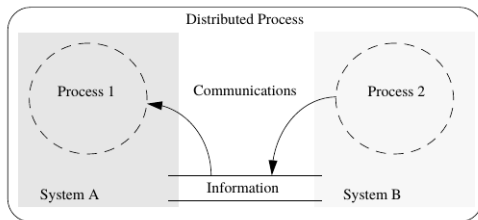
- ▶ *Formát souboru* (vč. informací pacienta, acquisition data, kontext studie – pro spojení s příslušným ošetřením)
- ▶ *Síťový protokol* (výměna informací, zejm. obrázků).
- ▶ Zejména však *definice rozhraní* – důležité pro integraci výrobci zařízení. Zařízení mohou poskytovat i pořizovat (zobrazit) data z jiných zařízení.
- ▶ Pomocí specifikace IOD (Information Object Definition) si aplikace mohou vyměňovat virtuální objekty bez nutnosti znalosti aplikace na druhé straně (a znalosti tamější interní reprezentace).
- ▶ Před DICOMem byla takováto interoperabilita utopií.

Z čeho vychází?

Historicky,

- ▶ Obrázky bývaly zálohovány na magnetické pásky (9 stop), proprietární formáty (vendor specific).
- ▶ Import do jiného softwaru znamenal implementaci specifického proprietárního formátu.
- ▶ Toto se často opakovalo, protože výstupní formát byl také proprietární.
- ▶ Radiologie. Docházelo ke ztrátě filmů, docházel úložný prostor, stříbro zdražilo...

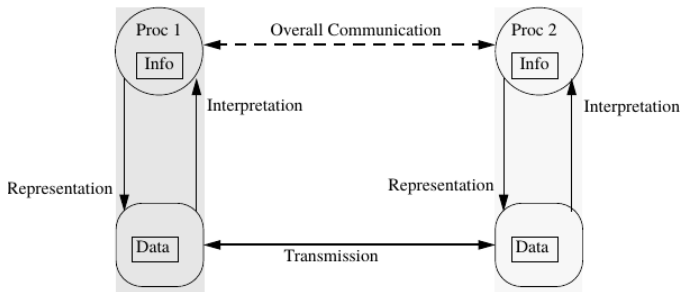
Distribuovaný proces



Obrázek: Distributed process

- ▶ *Distribuované procesy poskytují služby (services) dalším systémům.*
- ▶ Např. modalities, archive, workstations poskytují *services*: např. pořízení (akvizice) obrazu, a zobrazení.

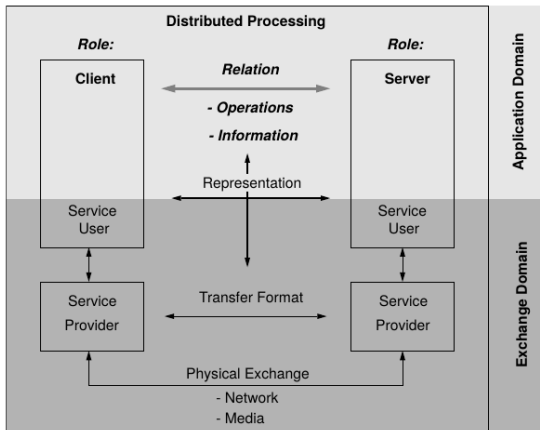
Distribuovaný proces



Obrázek: Decoupling

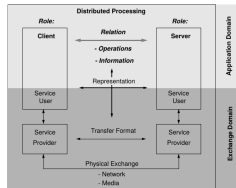
- ▶ Striktní oddělení aplikačních a komunikačních procesů.

Distribuovaný proces



Obrázek: Model distribuovaného procesu

Distribuovaný proces

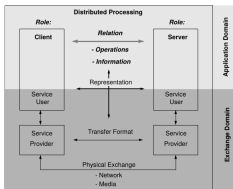


Obrázek: Model distribuovaného procesu

Application domain:

- ▶ Nutné definovat *role*: Klient/server
- ▶ Nutné definovat *rámec informací*, kt. jsou vyměřovány. Důležitá je sémantika, nikoliv syntaxe. Důležitý je *kontext*.
- ▶ Nutné definovat *operace*. Např. ukládání, vrácení výsledku, apod.

Distribuovaný proces

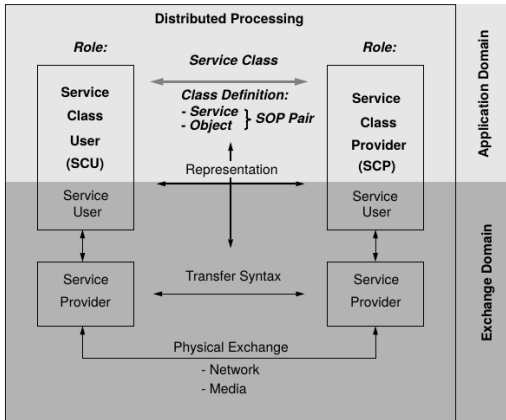


Obrázek: Model distribuovaného procesu

Exchange domain (skrytá pro uživatele):

- ▶ Service user, Service provider: Mohou mít různou (vnitřní) implementaci. Musí však používat stejné komunikační protokoly a rozhraní (request format).
- ▶ Nutné definovat datovou reprezentaci (ABI).
- ▶ Fyzická výměna, např. síť, paměťové médium.

Dicom concepts



Obrázek: DICOM Service classes

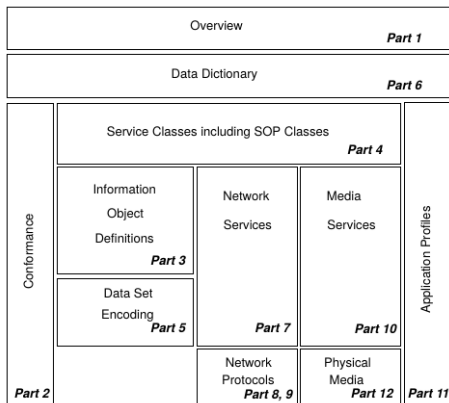
Části standardu

- ▶ DICOM Part 1: Introduction and Overview (34 str.)
- ▶ DICOM Part 2: Conformance (322)
- ▶ DICOM Part 3: Information Object Definitions (1424)
- ▶ DICOM Part 4: Service Class Specifications (414)
- ▶ DICOM Part 5: Data Structures and Encoding (138)
- ▶ DICOM Part 6: Data Dictionary (232)
- ▶ DICOM Part 7: Message Exchange (128)
- ▶ DICOM Part 8: Network Communication Support for Message Exchange (72)
- ▶ DICOM Part 10: Media Storage and File Format for Media Interchange (48)
- ▶ ...

Části standardu

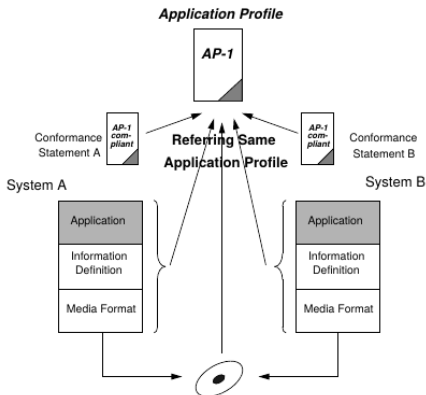
- ▶ ...
- ▶ DICOM Part 11: Media Storage Application Profiles (96 str.)
- ▶ DICOM Part 12: Media Formats and Physical Media for Media Interchange (92)
- ▶ DICOM Part 14: Grayscale Standard Display Function (66)
- ▶ DICOM Part 15: Security and System Management Profiles (142)
- ▶ DICOM Part 16: Content Mapping Resource (1228)
- ▶ DICOM Part 17: Explanatory Information (764)
- ▶ DICOM Part 18: Web Services (158)
- ▶ DICOM Part 19: Application Hosting (96)
- ▶ DICOM Part 20: Imaging Reports using HL7 Clinical Document Architecture (152)

DICOM Standards



Obrázek: Vzáj. vztahy částí standardu

DICOM Standards: APP Conformance



Obrázek: Application Profile Conformance

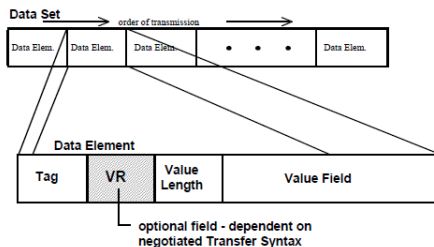
Popis elementů DICOM

```
# Dicom-Data-Set
# Used TransferSyntax: UnknownTransferSyntax
(0008,0016) UI =SecondaryCaptureImageStorage # 26, 1 SOPClassUID
(0028,0002) US 3 # 2, 1 SamplesPerPixel
(0028,0004) CS [YBR_FULL_422] # 12, 1 PhotometricInterpretation
(0028,0006) US 0 # 2, 1 PlanarConfiguration
(0028,0010) US 96 # 2, 1 Rows
(0028,0011) US 372 # 2, 1 Columns
(0028,0100) US 8 # 2, 1 BitsAllocated
TAG(028,0101) US 8 # 2, 1 BitsStored
(0028,0102) US 7 # 2, 1 HighBit
(0028,0103) VM US 0 # 2, 1 PixelRepresentation
(0028,2110) Value[01] # 2, 1 ValueLengtheCompresValue Multiplicity (VM)
(0028,2114) CS [ISO_10918_1] # 12, 1 LossyImageCompressionMethod
(7fe0,0010) OB (PixelSequence #=2) # u/1, 1 PixelData
(fffe,e000) pi (no value available) # 0, 1 Item
(fffe,e000) pi
ff\d8\xff\db\00\43\00\08\06\06\07\06\05\08\07\07\07\09\09\08\0a\0c... # 9624, 1
Item
(fffe,e0dd) na (SequenceDelimitationItem) # 0, 0 SequenceDelimitationItem
```

Obrázek: Popis elementů DICOM

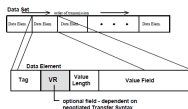
Objekty DICOM

- ▶ DICOM Element
- ▶ DICOM Attribute
- ▶ Podobné objektům OOP



Obrázek: DICOM Element

Objekty DICOM: Tag



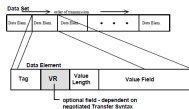
Obrázek: DICOM Element

- ▶ Jednoznačně definovaný, viz kap. 6 standardu.
- ▶ Jasně definované vlastnosti
- ▶ {Group_Tag, Element_Tag},
i.e.: (7FE0,0010): Pixel data, nebo (0028,*): Image group

DICOM Hexdump: Image group

```
(0x0028,0x0002) US Samples per Pixel      VR=<US>    VL=<0x0002>  [0x0001]
(0x0028,0x0004) CS Photometric Interpretation  VR=<CS>    VL=<0x000c>  <MONOCHROME2 >
(0x0028,0x0010) US Rows                    VR=<US>    VL=<0x0002>  [0x0200]
(0x0028,0x0011) US Columns                  VR=<US>    VL=<0x0002>  [0x0200]
(0x0028,0x0030) DS Pixel Spacing            VR=<DS>    VL=<0x0012>  <0.488281\0.488281 >
(0x0028,0x0100) US Bits Allocated          VR=<US>    VL=<0x0002>  [0x0010]
(0x0028,0x0101) US Bits Stored              VR=<US>    VL=<0x0002>  [0x000c]
(0x0028,0x0102) US High Bit                 VR=<US>    VL=<0x0002>  [0x000b]
(0x0028,0x0103) US Pixel Representation      VR=<US>    VL=<0x0002>  [0x0000]
(0x0028,0x1050) DS Window Center            VR=<DS>    VL=<0x0004>  <1951>
(0x0028,0x1051) DS Window Width            VR=<DS>    VL=<0x0004>  <237 >
```

Objekty DICOM: Value Representation (VR)



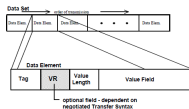
Obrázek: DICOM Element

- ▶ Jednoznačně definovaný, 2 znaky.
Viz tab. 6.2-1 standardu.
- ▶ *Tag* implicitně definuje VR.
Dle IHE je doporučeno VR explicitně uvádět.
- ▶ CS: Coded String, US: Unsigned Short, OB: Other Byte, DS: Decimal String, TM: Time, DA: Date, DT: DateTime (YYYYMMDDHHMMSS.FFFFFFFF&ZZXX), ...
Celkem cca 30.

DICOM Hexdump: Image group

```
(0x0028,0x0002) US Samples per Pixel      VR=<US>    VL=<0x0002>  [0x0001]
(0x0028,0x0004) CS Photometric Interpretation  VR=<CS>    VL=<0x000c>  <MONOCHROME2 >
(0x0028,0x0010) US Rows                    VR=<US>    VL=<0x0002>  [0x0200]
(0x0028,0x0011) US Columns                 VR=<US>    VL=<0x0002>  [0x0200]
(0x0028,0x0030) DS Pixel Spacing           VR=<DS>    VL=<0x0012>  <0.488281\0.488281 >
(0x0028,0x0100) US Bits Allocated          VR=<US>    VL=<0x0002>  [0x0010]
(0x0028,0x0101) US Bits Stored             VR=<US>    VL=<0x0002>  [0x000c]
(0x0028,0x0102) US High Bit                VR=<US>    VL=<0x0002>  [0x000b]
(0x0028,0x0103) US Pixel Representation     VR=<US>    VL=<0x0002>  [0x0000]
(0x0028,0x1050) DS Window Center           VR=<DS>    VL=<0x0004>  <1951>
(0x0028,0x1051) DS Window Width           VR=<DS>    VL=<0x0004>  <237 >
```

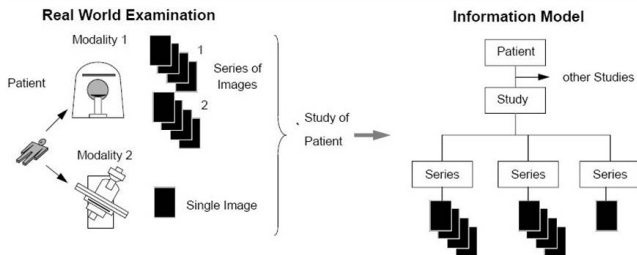
Objekty DICOM: Value Length (VL)



Obrázek: DICOM Element

- ▶ Vždy sudý počet.
Padding. 0x20 pro řetězce, 0x00 pro binární typy.
- ▶ *Tag* implicitně definuje VR.
Dle IHE je doporučeno VR explicitně uvádět.
- ▶ CS: Coded String, US: Unsigned Short, OB: Other Byte, DS: Decimal String, TM: Time, DA: Date, DT: DateTime (YYYYMMDDHHMMSS.FFFFFFFF&ZZXX), ...
Celkem cca 30.

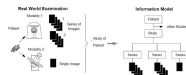
Datový model DICOM



Obrázek: Datový model: IE (Informační entity)

- ▶ Relační model
- ▶ – Patient, Study, Series, Image
- ▶ – Visit, Equipment, Clinical Trial, Procedure, ...

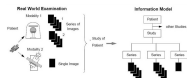
Datový model DICOM



Obrázek: Datový model: IE (Informační entity)

- ▶ SOP (Service Object Pair) lze vnímat jako dvojici: Objekt (obrázek) a službu (retrieve)

Datový model DICOM

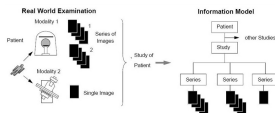


Obrázek: Datový model: IE (Informační entity)

- ▶ Třídy statického datového modelu: **SOP** (Service Object Pair) Classes (jsou definovány **IOD**: Information Object Definition, viz kap. 3 standardu).
- ▶ IOD: kolekce Modulů. Modul je kolekcí elementů z jedné informační entity. Viz kap. 3 standardu.
- ▶ Všechny objekty DICOM musí obsahovat *SOP Common module* a moduly z hlavních IE (Patient M., General Study M., General Series M., Image/Instance).

Obrázek musí obsahovat Image Module.

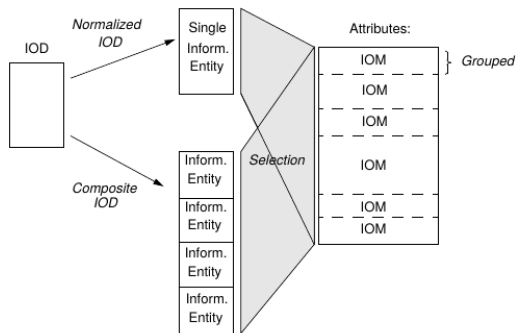
Datový model DICOM



Obrázek: Datový model: IE (Informační entity)

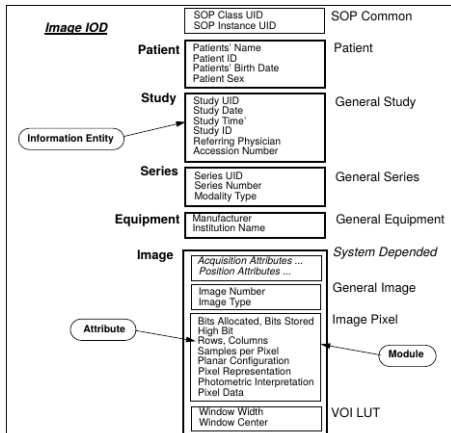
- Datový model je normalizovaný. Objekty DICOM nikoliv (jsou kompozitní). Interní reprezentace je záležitostí dodavatele/tvůrce systému. Důležité je rozhraní. (Viz N a C operace síťového protokolu)

IOD: C, N



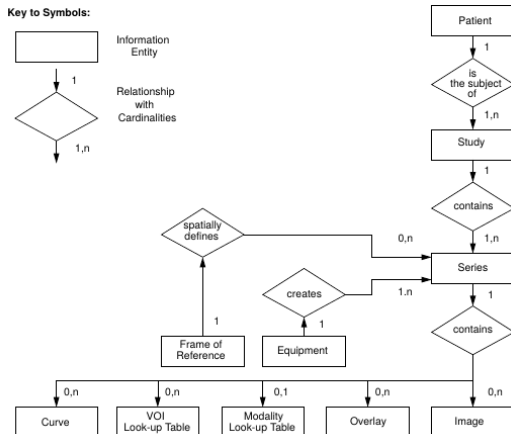
Obrázek: Vztahy IOD a atributy

Image IOD: Composite



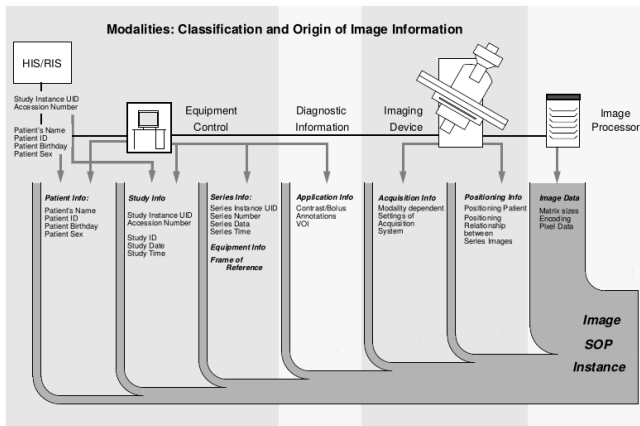
Obrázek: Composite image IOD, example

Image IOD: Composite



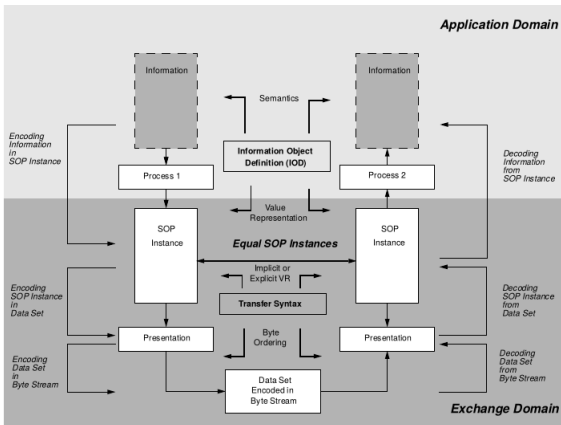
Obrázek: Composite image IOD, Information model

Image IOD: Composite



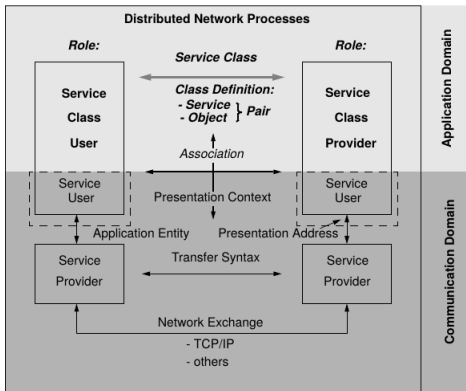
Obrázek: Classification of Image Information

Service Encode/decode flow



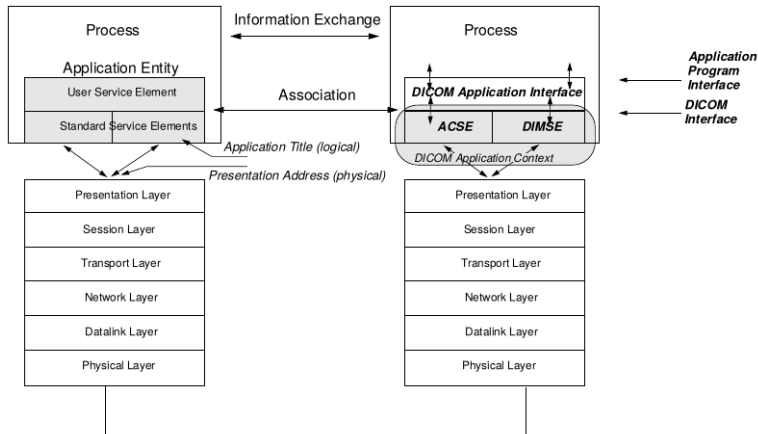
Obrázek: Encoding/Decoding SOP Instances

DICOM Networking



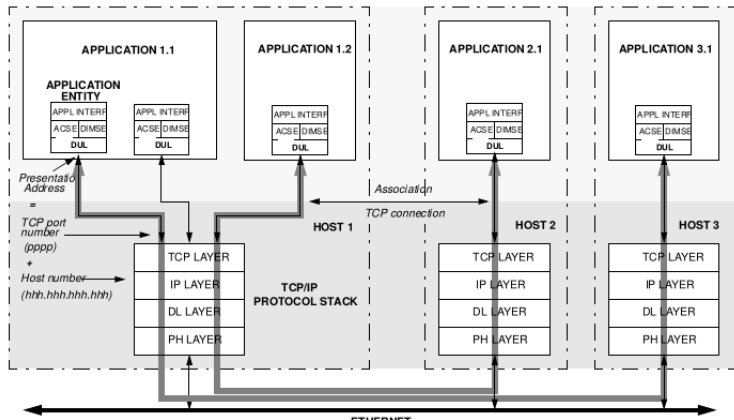
Obrázek: Networking concept in DICOM

DICOM Networking: ISO/OSI



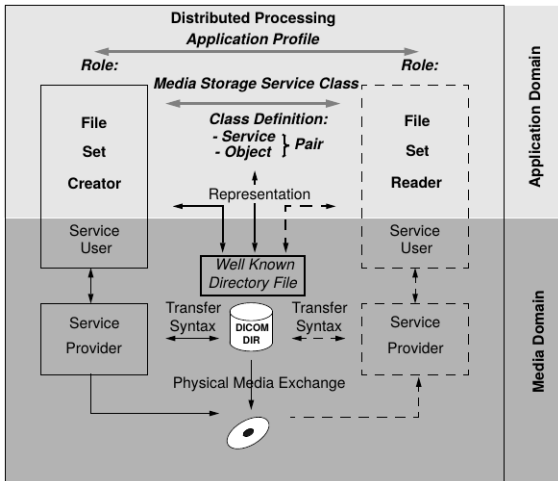
Obrázek: Networking concept in DICOM in OSI model

DICOM Networking: TCP

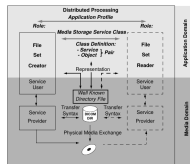


Obrázek: Networking concept in DICOM: TCP Connection

DICOM Storage



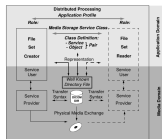
DICOM Storage



Obrázek: DICOM w. Storage Media Exchange

- ▶ DICOM File Format: SOP Class, SOP Instance, Transfer Syntax (UIDs)
- ▶ DICOM Directory Format (DICOMDIR)
- ▶ Physical Medium

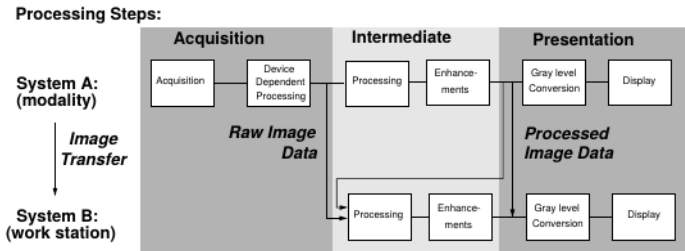
DICOM Image Services



Obrázek: DICOM w. Storage Media Exchange

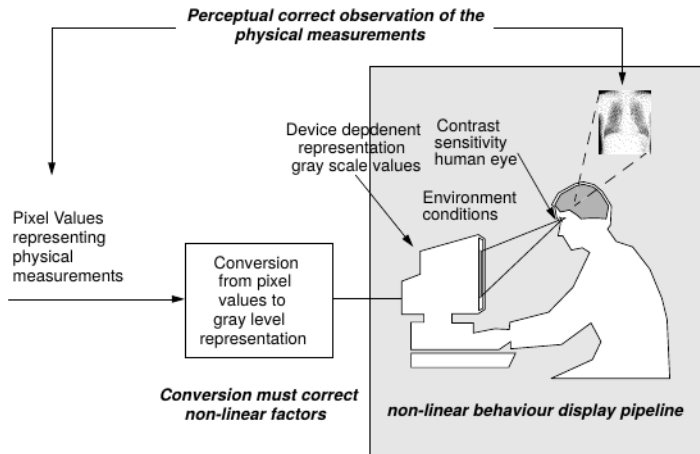
- ▶ Image Storage Service Classes (Storage, Query/Retrieve, Study Contents Notification)
- ▶ Management Service Classes (Detached Patient Management, Detached Study Management, Detached Result Management, Basic Worklist Management)
- ▶ Media Storage Service Class
- ▶ Verification Service Class (i.e.: C-ECHO)

DICOM Image: Processing and data types

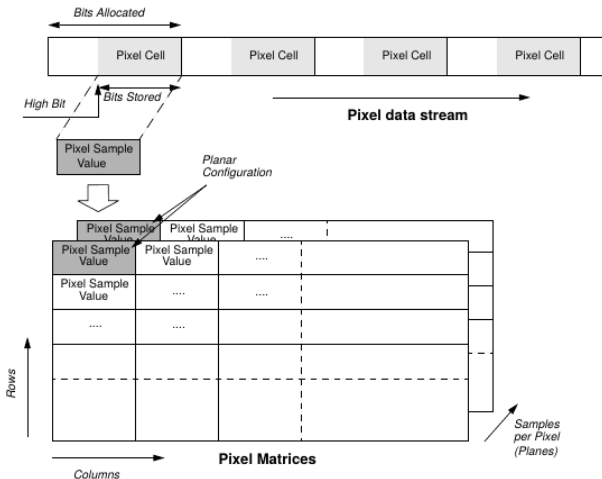


Obrázek: Processing and Raw/Processed Data Types

DICOM Image: Display pipeline



DICOM Image: Decoding pixel data



DICOM Image: Rescale and Conversion

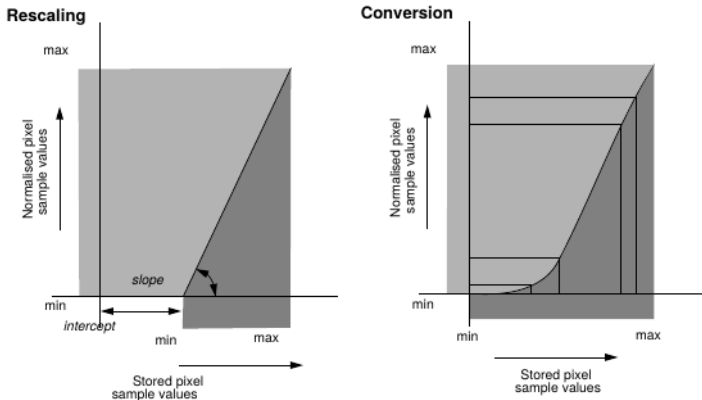
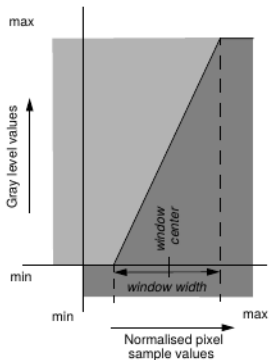


Figure 2-11: Modality Dependent Rescale and Conversion

DICOM Image: Rescale and Conversion

Window Center and Window Width



Conversion with Rounded Edges

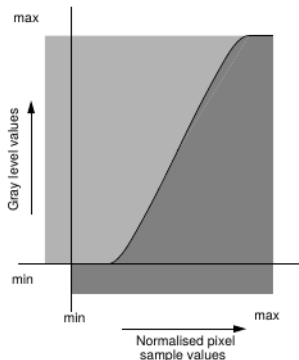
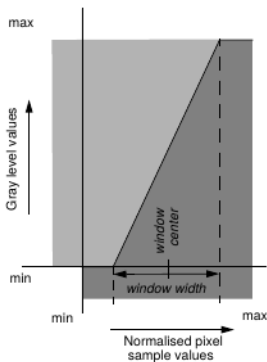


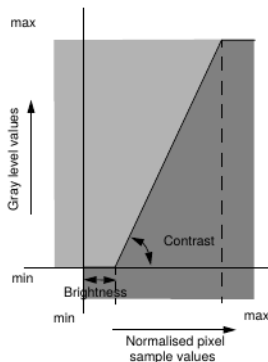
Figure 2-12: Gray Level Conversion

DICOM Image: Rescale and Conversion

Window Center and Window Width



Contrast and Brightness



Obrázek: Window Attributes vs. Contrast Brightness

IOD: Secondary Capture Image

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	U
	SC Equipment	C.8.6.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	SC Image	C.8.6.2	M
	Overlay Plane	C.9.2	U
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

Obrázek: IOD Modules (SC)

- Viz sekce A.8.1.3 standardu; M: Mandatory, U: User opt.

IOD: Secondary Capture Image

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
Series	General Series	C.7.3.1	M
Equipment	SC Equipment	C.8.6.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	SC Image	C.8.6.2	M
	SOP Common	C.12.1	M

Obrázek: IOD Mandatory Modules (SC)

- ▶ Viz sekce A.8.1.3 standardu
- ▶ M: Mandatory, U: User optional

C.7.6.1: General Image (M)

C.7.6.1 General Image Module

Table C.7-9 specifies the Attributes that identify and describe an image within a particular series.

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	2	A number that identifies this image. <i>Note</i> This Attribute was named Image Number in earlier versions of this Standard.
Patient Orientation	(0020,0020)	2C	Patient direction of the rows and columns of the image. Required if image does not require Image Orientation (Patient) (0020,0037) and Image Position (Patient) (0020,0032). May be present otherwise. See Section C.7.6.1.1 for further explanation. <i>Note</i> IODs may have attributes other than Patient Orientation, Image Orientation, or Image Position (Patient) to describe orientation in which case this attribute will be zero length.
Content Date	(0008,0023)	2C	The date the image pixel data creation started. Required if image is part of a series in which the images are temporally related. May be present otherwise. <i>Note</i> This Attribute was formerly known as Image Date.
Content Time	(0008,0031)	2C	The time the image pixel data creation started.

Obrázek: General Image Module (part), kap. 3

- ▶ Typ: 1: Mandatory with value (non zero len)
- 2: Mandatory (can be zero len]
- 3: Optional; 1C, 2C: Mandatory for some condition

Unique IDs, UIDs

- ▶ Každá třída SOP má svůj UID (Unique ID), viz kap. 6 standardu
- ▶ Např: *SOP Instance UID* (DICOM Object)
- ▶ DICOM zjišťuje, že jsou globálně jedinečné: Každá aplikace si zajistí své *root* UID, který používá jako prefix pro vytváření svých UID.
(Administrátoři přidělí prostřednictvím služby Modality Worklist DICOM service).
- ▶ Series Instance UID a SOP Instance UID generuje zobrazovací zařízení
- ▶ DICOM archiv (PACS) využívá UID k indexaci databáze (pro dotazování)

Patient Module Attributes: C.7-1 Selection

Attribute Name	Tag	Type	Attribute Description
Patient's Name	(0010,0010)	2	Patient's full name.
Patient ID	(0010,0020)	2	Primary hospital identification number or code for the patient.
Patient's Birth Date	(0010,0030)	2	Birth date of the patient.
Patient's Sex	(0010,0040)	2	Sex of the named patient, enum (M, F, O)
Patient's Birth Time	(0010,0032)	3	Birth time of the Patient.
>Patient ID	(0010,0020)	1	An identification number or code used to identify the patient.
>Type of Patient ID	(0010,0022)	1	The type of identifier in this item (TEXT, RFID, BARCODE).
Patient Species Description	(0010,2201)	1C	The species of the patient. Required if the patient is an animal and if Patient Species Code Sequence (0010,2202) is not present. May be present otherwise.
De-identification Method	(0012,0063)	1C	A description or label of the mechanism or method use to remove the patient's identity. May be multi-valued if successive de-identification steps have been performed.

General Study Module Attributes: C.7-3 Selection

Attribute Name	Tag	Type	Attribute Description
Study Instance UID	(0020,000D)	1	Unique identifier for the Study.
Study Date	(0008,0020)	2	Date the Study started.
Study Time	(0008,0030)	2	Time the Study started.
Referring Physician's Name	(0008,0090)	2	Name of the patient's referring physician
Referring Physician Identification Sequence	(0008,0096)	3	Identification of the patient's referring physician. Only a single item is permitted in this sequence.
Study ID	(0020,0010)	2	User or equipment generated Study identifier.
Accession Number	(0008,0050)	2	A RIS generated number that identifies the order for the Study.

General Series Module Attributes: C.7-5a Selection

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series.
>Study Instance UID	(0020,000D)	1	Instance UID of Study to which the related Series belongs
>Series Instance UID	(0020,000E)	1	Instance UID of Related Series
Series Number	(0020,0011)	2	A number that identifies this Series.
Laterality	(0020,0060)	2C	Laterality of (paired) body part examined. Required if the body part examined is a paired structure and Image Laterality (0020,0062) or Frame Laterality (0020,9072) are not sent. (L, R)

SC Equipment Module Attributes: C.8-24 Selection

Attribute Name	Tag	Type	Attribute Description
Conversion Type	(0008,0064)	1	Describes the kind of image conversion. DV: Digitized Video, DI: Digital Interface, DF: Digitized Film, WSD: Workstation, SD: Scanned Document, SI: Scanned Image, DRW: Drawing, SYN: Synthetic Image
Modality	(0008,0060)	3	Source equipment for the image. This type definition shall override the definition in the General Series Module.

General Image Module Attributes: C.7-9 Selection

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	2	A number that identifies this image.
Patient Orientation	(0020,0020)	2C	Patient direction of the rows and columns of the image. Required if image does not require Image Orientation (Patient) (0020,0037) and Image Position (Patient) (0020,0032). May be present otherwise. See Section C.7.6.1.1.1 for further explanation.
Content Date	(0008,0023)	2C	The date the image pixel data creation started. Required if image is part of a series in which the images are temporally related. May be present otherwise.
Content Time	(0008,0033)	2C	The time the image pixel data creation started. Required if image is part of a series in which the images are temporally related. May be present otherwise.

Image Pixel Macro Attributes: Selection

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.7.6.3.1.1 for further explanation.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.7.6.3.1.2 for further explanation.
Rows	(0028,0010)	1	Number of rows in the image.
Columns	(0028,0011)	1	Number of columns in the image
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See PS3.5 for further explanation.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See PS3.5 for further explanation.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. See PS3.5 for further explanation.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. (0000H: unsigned integer, 0001H: 2's complement)
Pixel Data	(7FE0,0010)	1C	A data stream of the pixel samples that comprise the Image. See Section C.7.6.3.1.4 for further explanation. Required if Pixel Data Provider URL (0028,7FE0) is not present.
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are sent color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See Section C.7.6.3.1.3 for further explanation.

SOP Common Module Attributes: C.12-1 Selection

Attribute Name	Tag	Type	Attribute Description
SOP Class UID	(0008,0016)	1	Uniquely identifies the SOP Class. See Section C.12.1.1.1 for further explanation. See also PS3.4.
SOP Instance UID	(0008,0018)	1	Uniquely identifies the SOP Instance. See Section C.12.1.1.1 for further explanation. See also PS3.4.
Specific Character Set	(0008,0005)	1C	Character Set that expands or replaces the Basic Graphic Set. Required if an expanded or replacement character set is used. See Section C.12.1.1.2 for Defined Terms.

Multi-frame Module Attributes: C.7-14 Selection

Attribute Name	Tag	Type	Attribute Description
Number of Frames	(0028,0008)	1	Number of frames in a Multi-frame Image. See Section C.7.6.6.1.1 for further explanation.
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tag of the attribute that is used as the frame increment in Multi-frame pixel data. See Section C.7.6.6.1.2 for further explanation.
Stereo Pairs Present	(0022,0028)	3	The multi-frame pixel data consists of left and right stereoscopic pairs. See Section C.7.6.6.1.3 for further explanation. (YES, NO)

DICOM File Meta Information: Tab 7.1-1 Selection

- ▶ Skupina 0002 je vždy Little Endian Explicit (pouze pro soubory).
- ▶ *Transfer Syntax UID* (0002, 0010) je použito pro všechny další elementy (mimo skupinu 0002)

DICOM File Meta Information: Tab 7.1-1 Selection

Attribute Name	Tag	Type	Attribute Description
File Preamble	—	1	A fixed 128 byte field available for Application Profile or implementation specified use. If not used by an Application Profile or a specific implementation all bytes shall be set to 00H. File-set Readers or Updaters shall not rely on the content of this Preamble to determine that this File is or is not a DICOM File.
DICOM Prefix	—	1	Four bytes containing the character string "DICM". This Prefix is intended to be used to recognize that this File is or not a DICOM File.
File Meta Information Group Length	(0002,0000)	1	Number of bytes following this File Meta Element (end of the Value field) up to and including the last File Meta Element of the Group 2 File Meta Information
File Meta Information Version	(0002,0001)	1	This is a two byte field where each bit identifies a version of this File Meta Information header. In version 1 the first byte value is 00H and the second value byte value is 01H.
Media Storage SOP Class UID	(0002,0002)	1	Uniquely identifies the SOP Class associated with the Data Set. SOP Class UIDs allowed for media storage are specified in PS3.4 - Media Storage Application Profiles.
Media Storage SOP Instance UID	(0002,0003)	1	Uniquely identifies the SOP Instance associated with the Data Set placed in the file and following the File Meta Information.
Transfer Syntax UID	(0002,0010)	1	Uniquely identifies the Transfer Syntax used to encode the following Data Set. This Transfer Syntax does not apply to the File Meta Information.

DICOM File Meta Information: Tab 7.1-1 Selection

Attribute Name	Tag	Type	Attribute Description
File Preamble	—	1	A fixed 128 byte field available for Application Profile or implementation specified use. If not used by an Application Profile or a specific implementation all bytes shall be set to 00H. File-set Readers or Updaters shall not rely on the content of this Preamble to determine that this File is or is not a DICOM File.
DICOM Prefix	—	1	Four bytes containing the character string "DICM". This Prefix is intended to be used to recognize that this File is or not a DICOM File.
File Meta Information Group Length	(0002,0000)	1	Number of bytes following this File Meta Element (end of the Value field) up to and including the last File Meta Element of the Group 2 File Meta Information
File Meta Information Version	(0002,0001)	1	This is a two byte field where each bit identifies a version of this File Meta Information header. In version 1 the first byte value is 00H and the second value byte value is 01H.
Media Storage SOP Class UID	(0002,0002)	1	Uniquely identifies the SOP Class associated with the Data Set. SOP Class UIDs allowed for media storage are specified in PS3.4 - Media Storage Application Profiles.
Media Storage SOP Instance UID	(0002,0003)	1	Uniquely identifies the SOP Instance associated with the Data Set placed in the file and following the File Meta Information.
Transfer Syntax UID	(0002,0010)	1	Uniquely identifies the Transfer Syntax used to encode the following Data Set. This Transfer Syntax does not apply to the File Meta Information.

Transfer Syntax UID

Native:

Transfer Syntax UID	Description
1.2.840.10008.1.2	Implicit VR, Little Endian
1.2.840.10008.1.2.1	Explicit VR, Little Endian
1.2.840.10008.1.2.2	Explicit VR, Big Endian

Encapsulated RLE:

Transfer Syntax UID	Description
1.2.840.10008.1.2.5	Run Length Encoding, Lossless

Transfer Syntax UID: Native

Encapsulated JPEG:

Transfer Syntax UID	Description
1.2.840.10008.1.2.4.50	Baseline (1)
1.2.840.10008.1.2.4.51	Extended (2, 4)
1.2.840.10008.1.2.4.52	Extended (3, 5)
1.2.840.10008.1.2.4.53	Spectral selection, non-hierar. (6, 8)
1.2.840.10008.1.2.4.54	Spectral selection, non-hierar. (7, 9)
1.2.840.10008.1.2.4.55	Full progression, non-hierar. (10, 12)
1.2.840.10008.1.2.4.56	Full progression, non-hierar. (11, 13)
1.2.840.10008.1.2.4.57	Lossless, non-hierar. (14)
1.2.840.10008.1.2.4.58	Lossless, non-hierar. (15)
1.2.840.10008.1.2.4.59	Extended, hierar. (16, 18)
1.2.840.10008.1.2.4.60	Extended, hierar. (17, 19)
1.2.840.10008.1.2.4.61	Spectral selection, hierar. (20, 22)
1.2.840.10008.1.2.4.62	Spectral selection, hierar. (21, 23)
1.2.840.10008.1.2.4.63	Full progression, hierar. (24, 26)
1.2.840.10008.1.2.4.64	Full progression, hierar. (25, 27)
1.2.840.10008.1.2.4.65	Lossless, hierar. (28)
1.2.840.10008.1.2.4.66	Lossless, hierar. (29)
1.2.840.10008.1.2.4.70	Lossless, hierar., first-order pred. 14, Select. Val. 1)

DICOM prakticky

Pojďme se na to podívat...

DICOM prakticky

Více na cvičení

Díky...

...za pozornost

Nejen toto byste měli znát...

- ▶ Co je DICOM, PACS?
- ▶ Co je SOP, SOP Class, SOP Class UID? Příklad.
- ▶ Co je SCU/SCP? Ke které části std. se vztahuje?
- ▶ Co je IE/Modul/IOD (Composite)/Atribut? Viz obr. *Composite image IOD, example.*
- ▶ Co je syntaxe a sémantika? Co rozhraní (interface)? Co je API/ABI?
- ▶ Které standardizační organizace stojí za standardem DICOM?
- ▶ Co je conformance?
- ▶ Atribut Pixel data (7FE0, 0010). V jakém formátu je lze očekávat?
- ▶ ...

Nejen toto byste měli znát...

- ▶ ...
- ▶ Co je DICOM Element? Jaké znáte? Co je VR?
- ▶ Explicit vs. Implicit a BE vs LE.
- ▶ Datový model DICOM, IE: Real world vs. Inf. model (viz obr. *Datový model: IE (Informační entity)*).
- ▶ Co je Window Width/Window Center? Proč jsou potřeba? Kdo/co je určuje?
- ▶ Co jsou Modalities?
- ▶ Rozdíl mezi Bits Allocated a Bits Stored?
- ▶ DICOM File Meta Information. Kde je? Kde není? Jaké má číslo? Co je Transfer Syntax UID?
- ▶ Co je SC?