

The DICOM Standard

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Medical Image Formats

Typical information present in a file:

- Image data (unmodified or compressed)
- Patient identification and demographics
- Technical information about the scanner exam, series, and slice/image.

Basic Families of Formats

- **Fixed** – layout identical in all files
- **Block** – header with pointers to information
- **Tagged** – each item with its own length
 - Self contained and describing
 - Length is included
 - Not known/not needed ► just skip

Dirty Tricks to Read Data

- Image data is at the end
- 8/16 bits per pixel
- Size 256^2 or 512^2
- Unknown byte order

DICOM History

- **ACR/NEMA Standards Publication No. 300-1985**
ACR/NEMA 1.0
- **ACR/NEMA Standards Publication No. 300-1988**
ACR/NEMA 2.0
- **ACR/NEMA Standards Publication PS3 1992/93**
DICOM 3

ACR - American College of Radiologists

NEMA - National Electrical Manufacturers Association

DICOM - Digital Imaging and Communications in Medicine

What is DICOM

The format used in hospitals for image data today

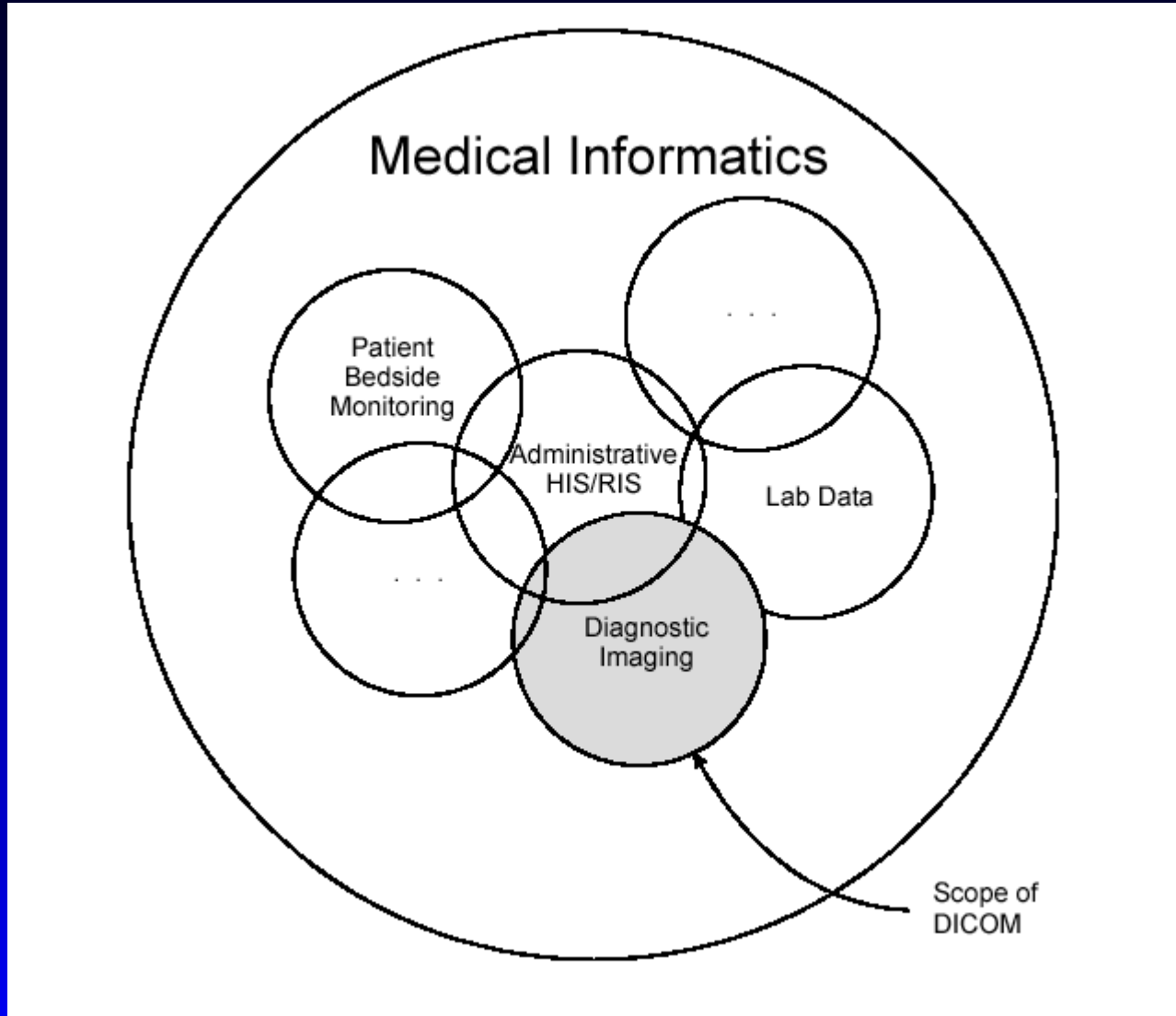
It defines:

- A set of *protocols* to be followed by devices claiming DICOM conformance
- The *syntax and semantics* of Commands and associated information which can be exchanged using these protocols
- Information that must be supplied with an implementation for which the DICOM *conformance* is claimed

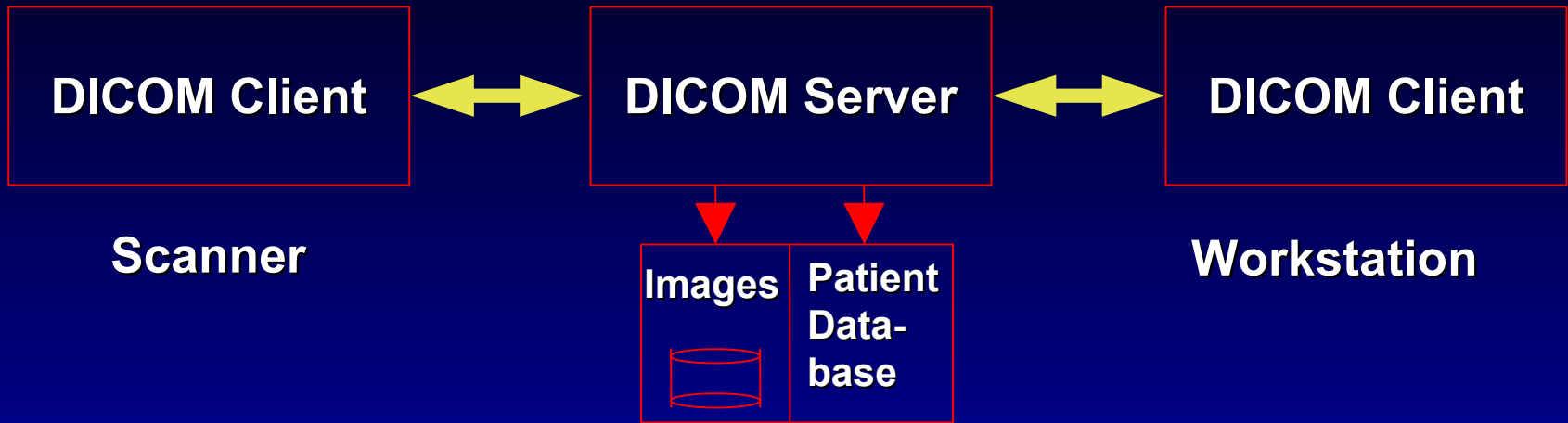
The DICOM Standard

- Full text available at
<http://medical.nema.org/dicom/2001.html>
- 16 parts
- Thousands of pages
- Derived and/or related standards:
 - ACR/NEMA Standard for Magnetic Tapes
 - Image Save & Carry (Magneto-optical disc)
 - Papyrus

Scope of DICOM

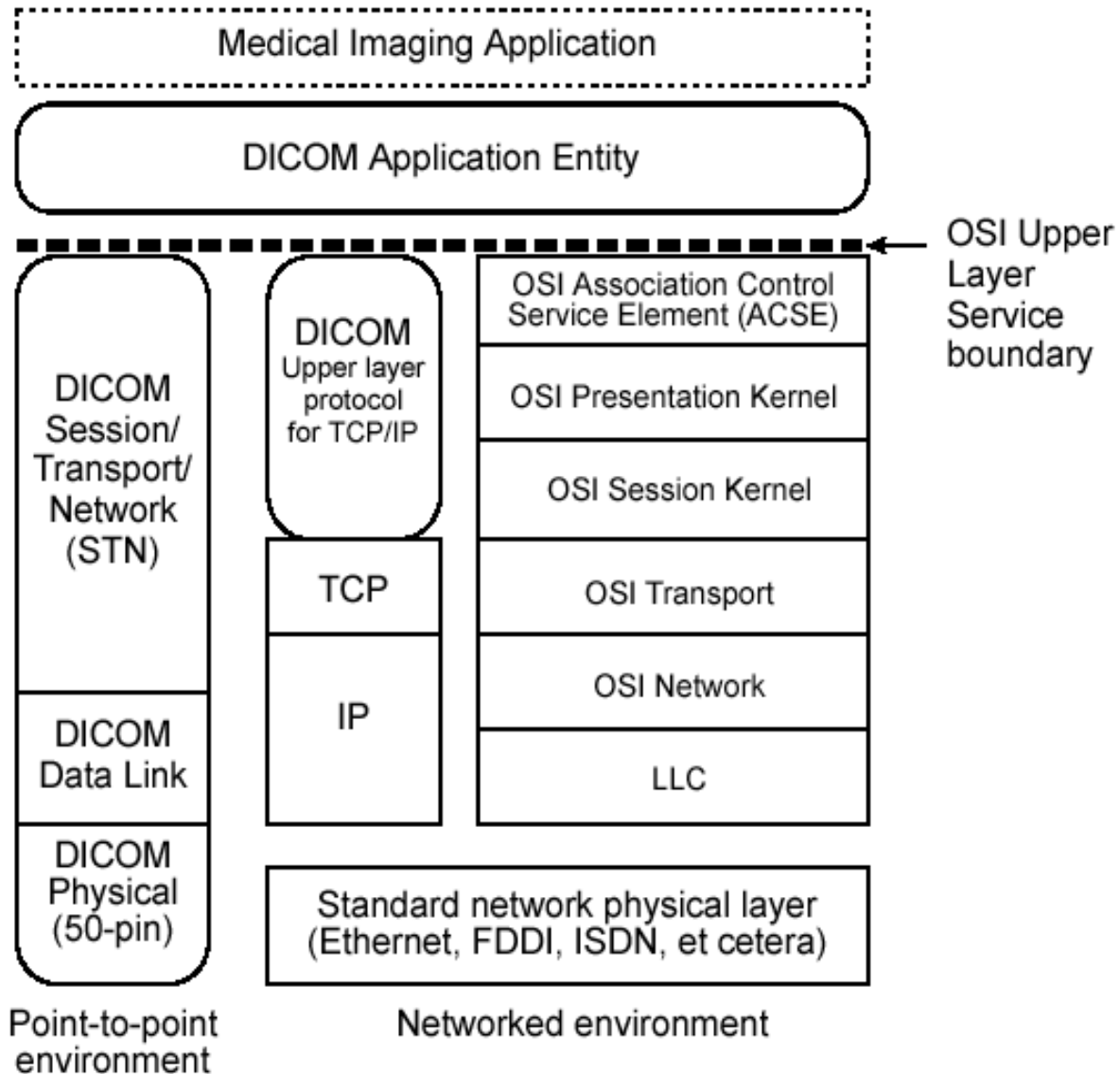


DICOM Concepts



- **Scanners store their data on the server**
- **Workstations query server for list of image data managed by the server.**
- **Server talks to database and provides results of query to the workstation.**
- **Workstation retrieves desired data and server gets data from disk or other media**

DICOM Network Model



DICOM Files

- Storage of data in databases
- Exchange of data by various media types

File structure:

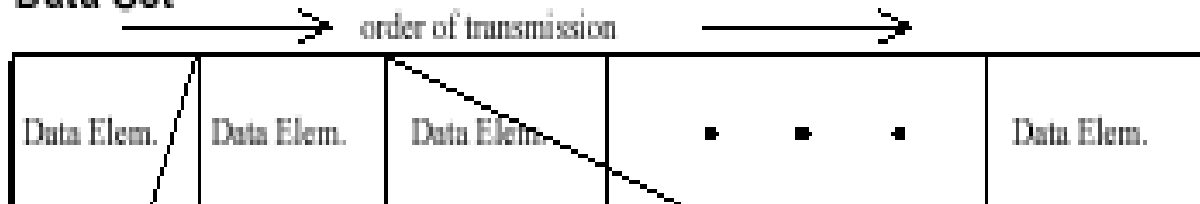
- DICOM File Meta Information
- DICOM Data Set/Message

A DICOM Data Set

- A sequence of Data Elements
- Data elements are ordered by increasing *Group* and *Data element numbers*

A DICOM Data Set

Data Set



Data Element



optional field - dependent on negotiated Transfer Syntax

DICOM Data Element

- Tag
 - Group number (8bit)
 - Data element number (8bit)
- Data length (32 bit)
- Data (length bytes)

A Data Element Example

0008	0010	000C	0000
------	------	------	------

4341	2D52	454E	414E	3120	302E
------	------	------	------	------	------

- **Tag: Recognition Code**
 - **Group: 0008**
 - **Data Element: 0010**
- **Length: 12 (000C)**
- **Data: SOME TEXT**

DICOM Groups

Even Numbers:

0008	Identifying information
0010	Patient
0018	Acquisition
0020	Relationship
0028	Image Presentation
4000	Text
6000-601E	Overlay
7FE0	Pixel Data

• **Odd numbers:** Vendor specific

Identifying Information

(0008,0020) AT S Study Date	# yyyy.mm.dd
(0008,0030) AT S Study Time	# hh.mm.ss.frac
(0008,0060) AT S Modality	# CT,NM,MR,DS,DR,US,OT

Patient Information

(0010,0010) AT S Patient Name

(0010,0030) AT S Patient birth date # yyyy.mm.dd

(0010,0040) AT S Patient Sex # M, F, O for other

(0010,1010) AT S Patient Age # xxxD or W or M or Y

Acquisition Information

(0018,0010) AT M Contrast/Bolus Agent	# or NONE
(0018,0050) AN S Slice Thickness	# mm
(0018,0080) AN S Repetition Time	# ms
(0018,0081) AN S Echo Time	# ms
(0018,1120) AN S Gantry Tilt	# degrees

Relationship Information

(0020,1040) AT S Position Reference # eg. iliac crest

(0020,1041) AN S Slice Location # in mm (signed)

Image Representation

(0028,0010) BI S Rows

(0028,0011) BI S Columns

(0028,0030) AN M Pixel Size # row\col in mm

(0028,0100) BI S Bits Allocated # eg. 12 bit for CT

(0028,0101) BI S Bits Stored # eg. 16 bit

(0028,0102) BI S High Bit # eg. 11

(0028,0103) BI S Pixel Representation

1 signed, 0 unsigned

Pixel Data

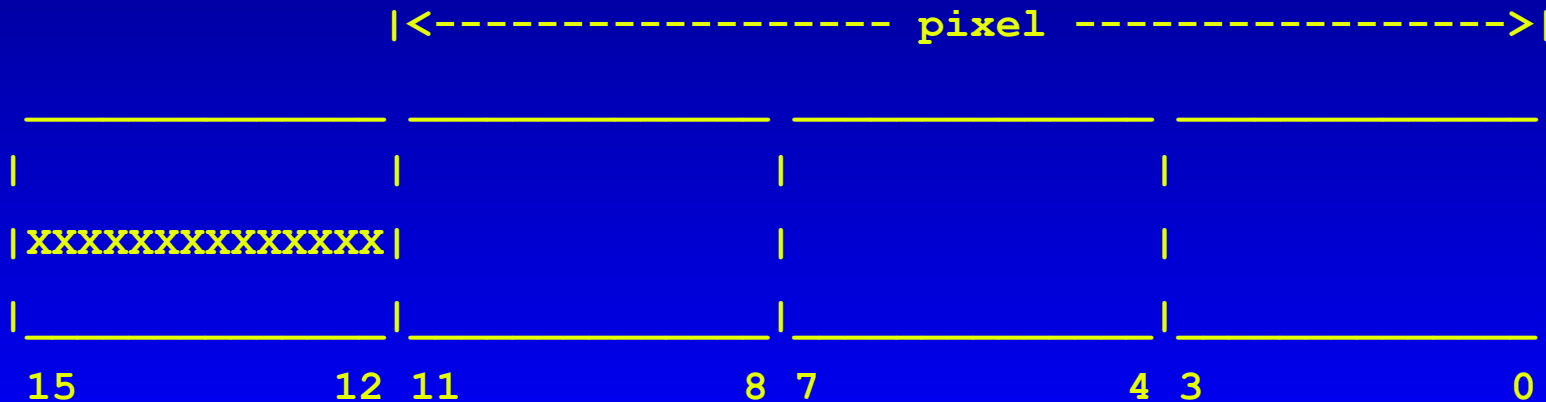
(7FE0,0010) BI M Pixel Data

Data Layout:

Bits Allocated = 16

Bits Stored = 12

High Bit = 11



DICOM File Meta Information

- **Mandatory header of each DICOM file**
- **Structure:**
 - **File preamble (128 bytes, unstructured)**
 - **DICOM Prefix (4 bytes, “DICM”)**
 - **Data elements with Group ID 0002**
 - **Element (0002,0010) defines Transfer Syntax UID**

Transfer Syntax (TS)

- A set of unambiguous encoding rules:
 - Byte ordering
 - Compression type
- Defined in data element (0002,0010)
- Applies to the DICOM Data Set
- TS UID (Unique ID): 1.2.840.10008.1.2.x.y.z
- Examples:
 - DICOM Default TS
 - DICOM Little/Big Endian TS (explicit VR)

DICOM Default Transfer Syntax

- **Implicit VR Little Endian Transfer Syntax**
- **UID: 1.2.840.10008.1.2**
- **Should be implemented by all systems**
- **Used for the DICOM File Meta Information (header)**

DICOM Resources

- The DICOM Standard
 - <http://medical.nema.org/dicom/2001.html>
- David Clunie's Medical Image Format Site
 - <http://www.dclunie.com>
 - Medical Image Format FAQ
 - Dicom3tools
- OFFIS:
 - <http://dicom.offis.de/dcmtdk.php.en>
- DICOM data:
 - <http://pubimage.hcuge.ch:8080>