MAIA

The digital hospital

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Before starting …

What is a digital hospital?

Before starting …

What sort of (**digital**) health data can you think of?

Before starting …

Image from: https://www.theatlantic.com/technology/archive/2014/03/electronic-medical-records-a-way-to-jack-up-billings-put-patients-in-control-or-both/359880/

Before starting …

What is a Digital Hospital? https://www.youtube.com/watch?v=Lmz7A40rLRI

Outline

- Introduction
  - Non-imaging data
  - Imaging data
- Standard protocols
- Typical standard protocols
  - HL7
  - DICOM
  - IHE
- PACS

Introduction

- **Health Record** (non-imaging data)
  - Clinical document with patient information to provide support to healthcare members.
  - Includes all medical information regarding a person.
  - Unique ID number to each patient/client.
  - Confidential.
  - Potential problems:
    - Large pieces of information -> time.
    - Fragmentation.
    - Illegibility.
    - Anonymisation

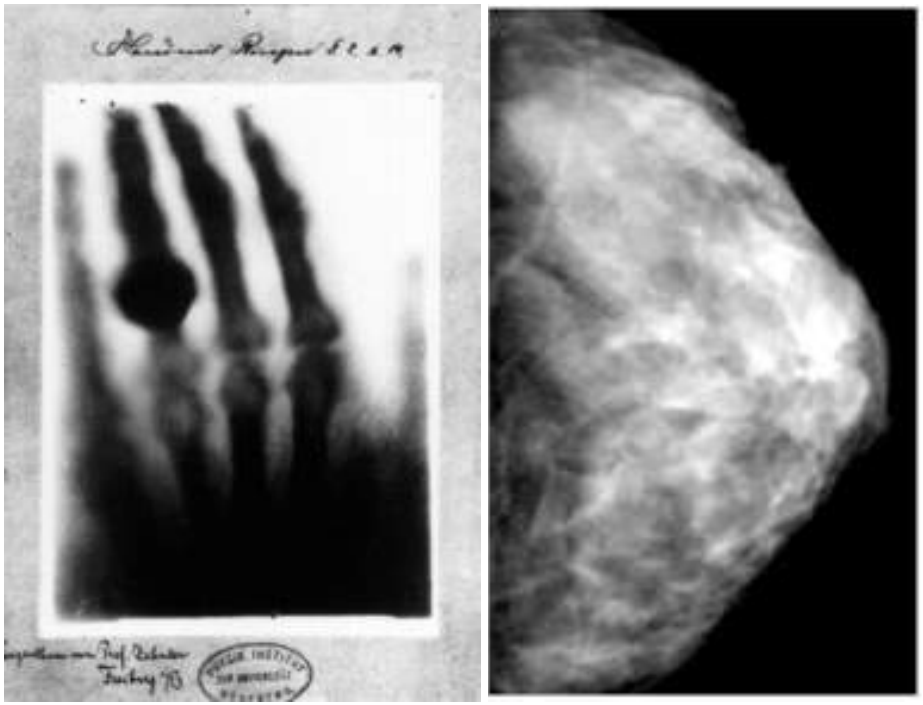
Handwriting

Welcome to the digital data era:
Electronic Health Record (EHR)

Introduction

- **Medical image** (imaging data)

Analogic



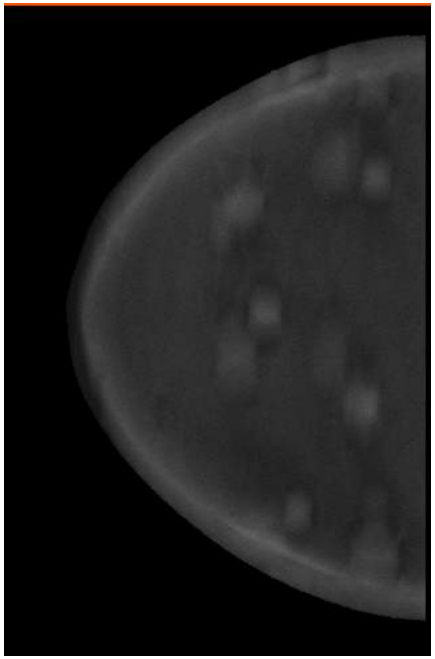
Digital

Introduction

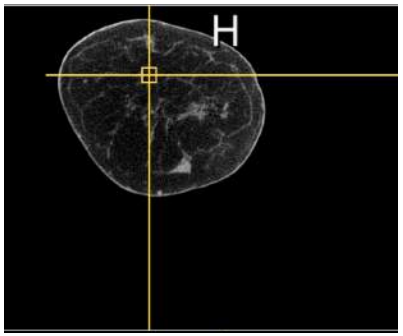
- **Medical image** (imaging data)

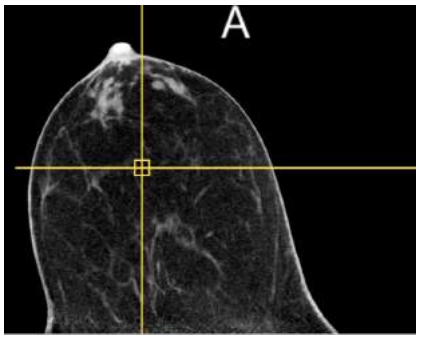
2D

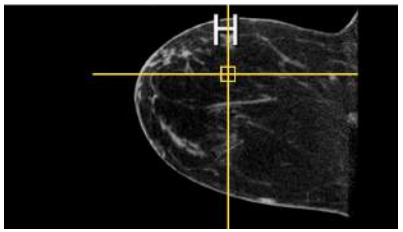
2.2D

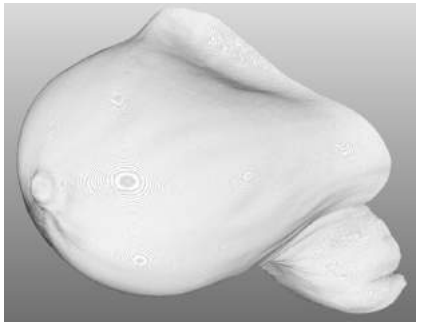


3D









4D

Standard protocols

What is a standard protocol for you?

Standard protocols

Why do we need standard protocols?

Standard protocols

- Why do we need standard protocols?
  - Efficient way to facilitate cost-effective & interoperable systems.
- Motivations for standards:
  - Arrival of new (digital) technology.
  - Digitalisation of clinical records.
  - Many vendors developing their own system or technology.
  - Interconnecting of various systems (sharing information)
  - Uniformity in appearance of images of different systems.

Standard protocols

- Imaging you are responsible for the healthcare system of a hospital. How should an information system be?
  - Reliable
  - Secure
  - Extensible
  - Allow interoperability (Technical, Semantic, Process)
  - Portable
  - Scalable
  - Not expensive

Standard protocols

- Most common standard protocols used clinically:
  - Non-imaging data: HL7
  - Imaging data: DICOM
  - IHE

HL7

HL7

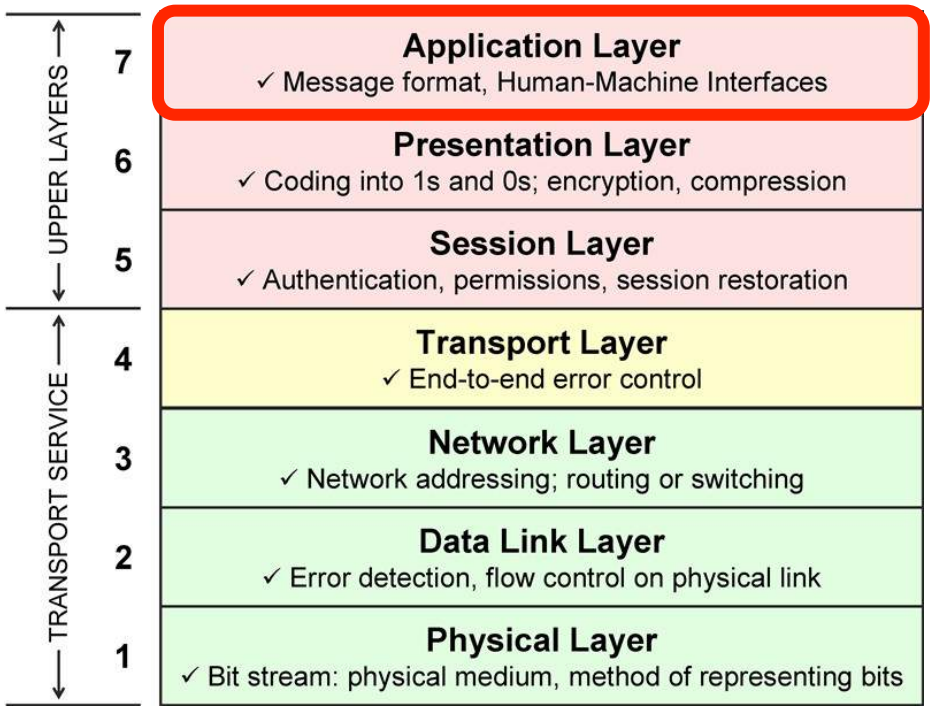
- Acronym for **Health Level Seven**.
- Non-profit international organisation (1987) supported by 1,600 member of 50+ countries.

http://www.hl7.org/

- HL7 enables **interoperability of healthcare information**.
- Creates standard for the **exchange**, **management** and **integration** of electronic data, i.e. non-imaging.
- **Develops specifications**: a message standard to enable exchange of clinical or administrative data.

ISO – model OSI

- The name of the standard Health Level 7 refers to the highest level of the Open System Interconnection (OSI) model of the ISO.



Architecture of ISO - OSI Model.

Source: http://nhprice.com/what-is-ios-model-the-overall-explanation-of-ios-7-layers.html

HL7: Features

- **HL7 does not develop software!** It provides specifications to make systems interoperable.
- Independent of the technology or platform.
- Allows the possibility to exchange information between application of different vendors.
- Reduces programming cost in development and maintenance.
- Flexibility to add new technological environments.

HL7 format

- HL7 is unbiased. It does not favour any particular vendor or organisation.

- HL7 specifies the format for exchange messages between systems.

- The general format of the **message data** field presents **items of variable length, separated by special characters**, according to specific coding rules.

Sample HL7 message

- Register a patient

```
MSH|^~\&|SENDING_APPLICATION|SENDING_FACILITY|RECEIVING_APPLICATION|
RECEIVING_FACILITY|20110613083617||ADT^A04|934576120110613083617|P|2.3||||
EVN|A04|20110613083617|||
PID|1||135769||MOUSE^MICKEY^||19281118|M|||123 Main St.^^Lake Buena Vista^FL^32830||
(407)939-1289^^^theMainMouse@disney.com|||||1719|99999999||||||||||||||||||
PV1|1|O|||||7^Disney^Walt^^MD^^^^|||||||||||||||||||||||||||||||||||||||||||
```

- Message
- Segments (header segment)
- Component
- Data

Field separator	|
Component separator	^
Field repeat separator	~
Escape separator	\
Sub component separator	&

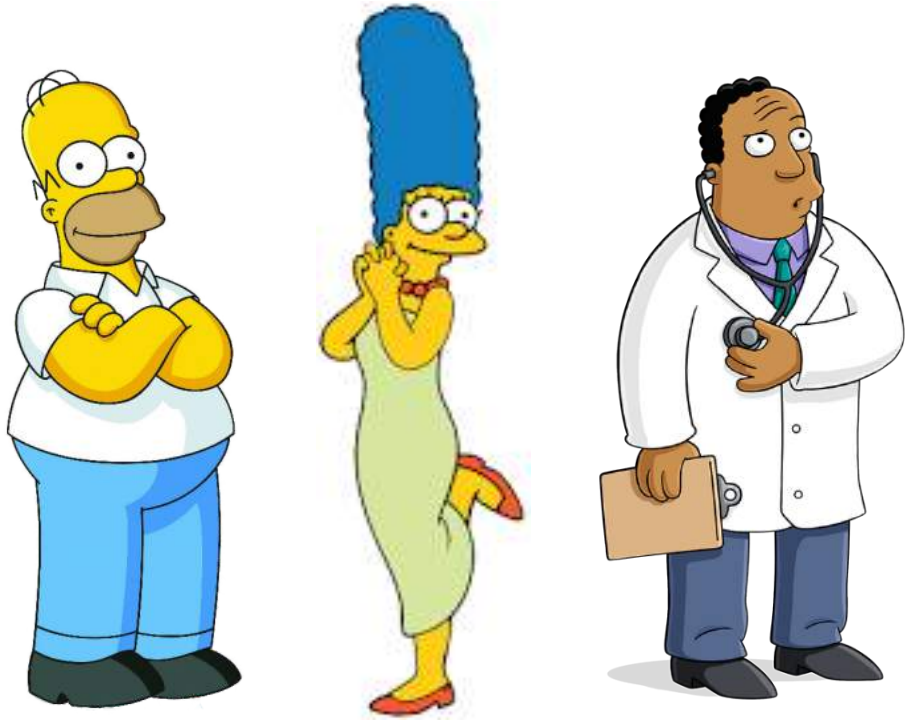
- HL7 message structure: https://docs.microsoft.com/en-us/biztalk/adapters-and-accelerators/accelerator-hl7/hl7-message-structure?redirectedfrom=MSDN

HL7: ADT message

- ADT **Admission message** (Basic information of the patient)

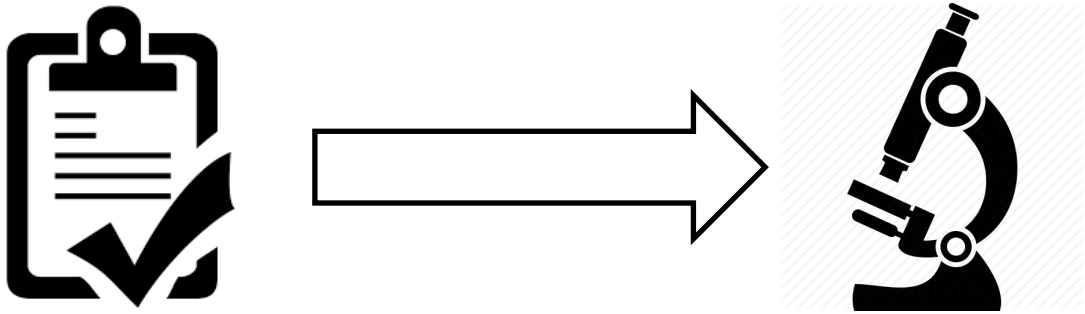
```
MSH|^~\&|EPIC|SYS|HOSP|ADT|201502031126|SEC|ADT^A01|001199|P|2.3
EVN|A01|201502031126
PID|||12001||SIMPSON^HOMER||19670824|M|||742 Evergreen Terrace St. ^^ Springfield ^ OR
^ 90020 ^ USA|||||||
NK1|1|SIMPSON^MARGE|WIFE|||||NK
PV1|1|I|2000^2012^01||||11277^HIBBERT^JULIUS^J|||SUR||-||ADM|A0-
AL1|1||^Penicillin||Hives
```

- **PID**: patient ID
- **NK1**: next of kin
- **PV1**: patient visit
- **AL1**: allergies



HL7: ORM message

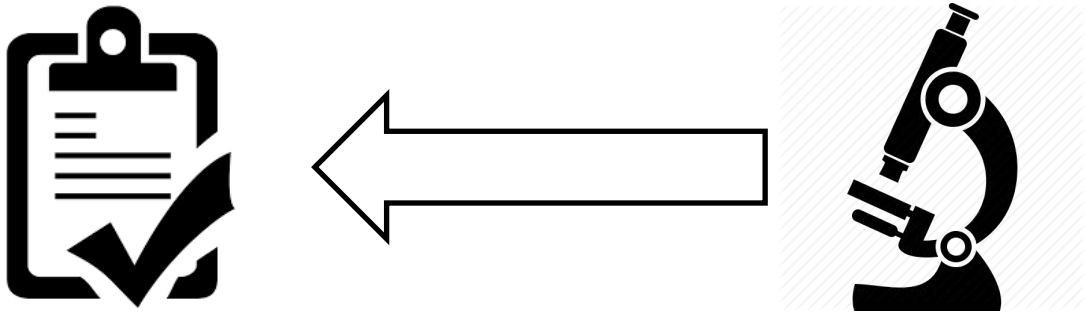
- ORM **Orders message that is placed for a Lab test**



```
MSH|^~\&|HIS|EPIC|LAB|HOSP|20140307110114
||ORM^O01|07110114|P|2.3
PID|||12001||SIMPSON^HOMER||19670824|M|||123 Fake St.^^Springfield^OR^90020^USA|||||||
PV1||O|OP^PAREG^||||2342^SIMPSON^HOMER|||OP|||||||||2|||||||
||||||||||||||||20140307110111|
ORC|NW|20140307110114
OBR|1|20140307110114||12345^Urinalysis^L|||20140307110114
```

HL7: ORM message

- ORM **Results coming back from Lab test**



```
MSH|^~\&|HIS|EPIC|LAB|HOSP|20140307110114||ORM^O01|07110114|P|2.3
PID|||12001||SIMPSON^HOMER||19670824|M|||123 Fake St.^^Springfield^OR^90020
^USA|||||||
PV1||O|OP^PAREG^||||2342^SIMPSON^HOMER|||OP|||||||2|||||||||||||||
|||||||20140307110111|
ORC|RE|20140307110114
OBR|1|20140307110114|20140307110114|12345^Urinalysis^L|
OBX|1|NM|013060^Specific Gravity^L||1.010||1.005-1.030|||N|F|
OBX|2|CE|013045^Urine-Color^L||Y^Yellow^L||Y|||N|F|
OBX|3|ST|013052^Appearance^L||Hazy||Clear|A||N|F
```

- More examples here: http://www.mieweb.com/wiki/Sample_HL7_Messages

HL7: Goals and Objectives

- Develop and publish standard protocols
- Promote the use in healthcare systems
- Promote education an outreach standards
- Promote service certification of conformity
- Define specifications to create extensions of the protocol
- Promote of HL7 internationally through affiliation

DICOM

DICOM

- Acronym for **Digital Imaging and COmunication in Medicine**.
- Promoted by the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA).

http://dicom.nema.org/

- DICOM is a vendor-independent standard for **handling, storing, printing**, and **transmitting** information in medical imaging and related data.
- Specifies the image format and protocol for exchanging images and related information.
- It includes a file format definition and a network communications protocol.

History of DICOM

- 1982: ACR-NEMA Committee formed
- 1983: ACR-NEMA meeting
- 1985: ACR-NEMA version 1.0
  - 1st data saving in media and communication between non-proprietary soft
- 1988: ACR-NEMA version 2.0
  - Terminology, data structure and encoding.
- **1992: ACR-NEMA version 3.0 or DICOM**
  - Rely on ISO/OSI model and use of TCP/IP protocol.
  - Unique identifiers (GGGG, NNNN).
- Supplements
  - **Suppl. 28 Grayscale Standard Display Function (GSDF), 1998**
    - Zoom, windowing, or annotations

http://www.dclunie.com/dicom-status/status.html

DICOM actions

- **Storage**
  - Send images or other objects to a PACS or workstation
- **Query/Retrieve**
  - List images or objects (any field) to be retrieved (from PACS)
    - Fields: image modality, date, patient ID, etc.
- **Print**
  - Send images to printer (x-ray film or hard image)

Field of medicine using DICOM

- Radiology
- Cardiology
- Oncology
- Radiotherapy
- Neurology
- Orthopedics
- Obstetrics
- Gynecology
- Ophthalmology
- Dentistry
- Maxillofacial surgery
- Dermatology
- Pathology
- Clinical trials
- Veterinary medicine

Imaging techniques using DICOM

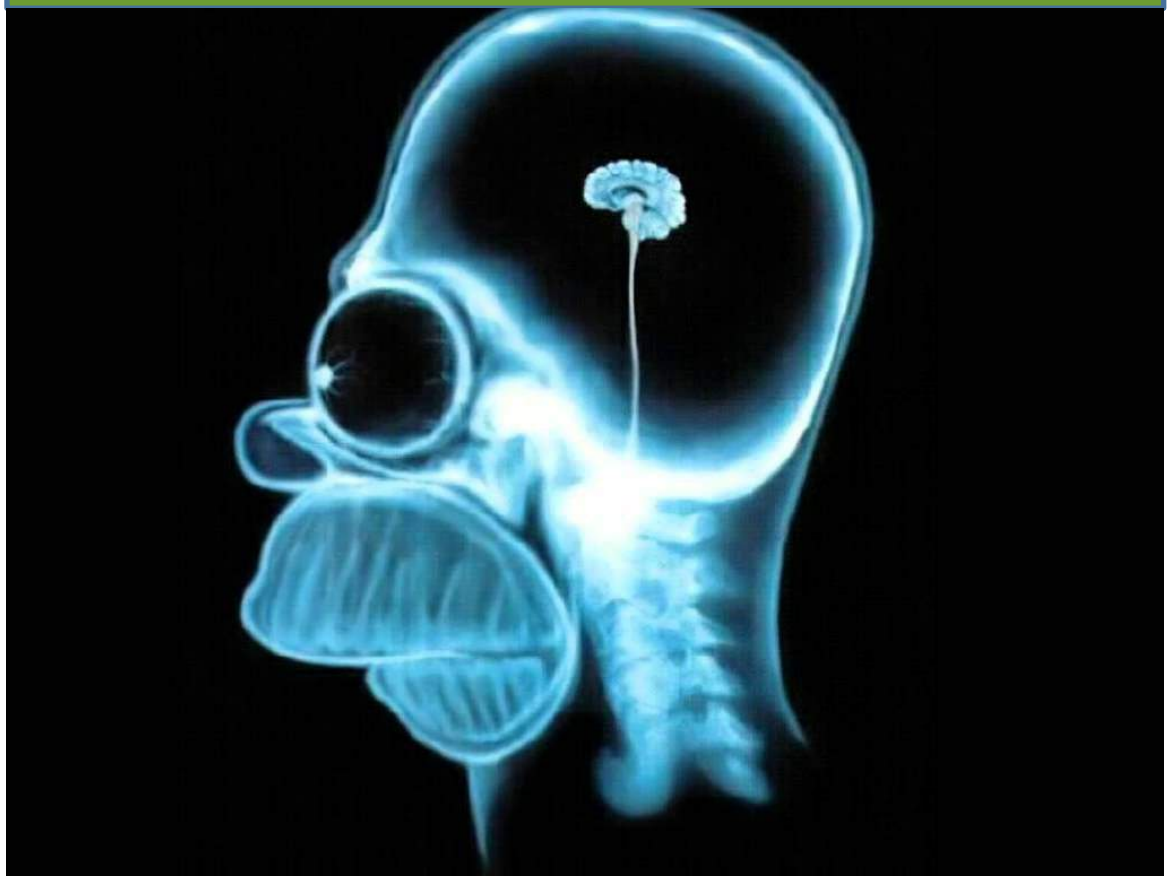
- X-ray imaging
  - CT (computed tomography)
  - Mammography
  - Digital breast tomosynthesis (DBT)
  - Fluoroscopy
  - Angiography
- MRI (magnetic resonance imaging)
- 2D/ 3D Ultrasound
- Nuclear medicine
  - PET (positron emission tomography)
  - SPECT (single photon emission computed tomography)
- Endoscopy
- Microscopy
- Whole slide imaging (WSI)
- Optical imaging
  - Optical coherence tomography (OCT)

DICOM

File extension: .dcm

(0010,0010): Anonymised00034
(0010,0020): XXX_72947
(0010,0030): 19000101
(0010,0040): M
(0010,1010): 039Y
(0018,0015): HEAD

Header



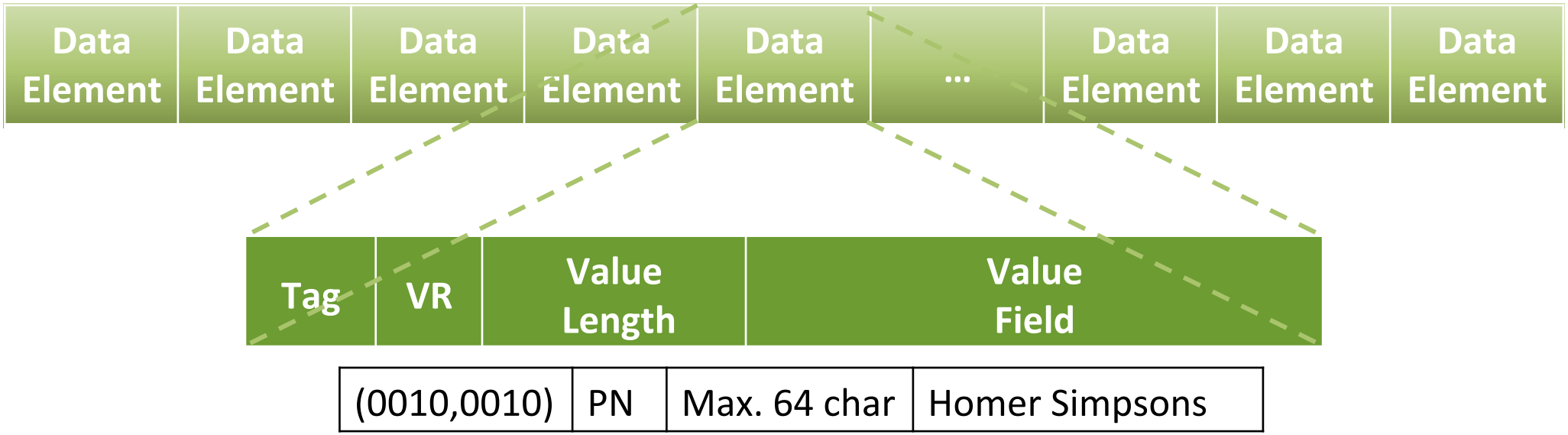
Image

DICOM header

- Contains information regarding:
  - Patient (Name, ID, DOB)
  - Study (Date, Time, …)
  - Series (Modality, Date, Time, …)
  - Equipment (Manufacturer, Model, Serial Number, …)
  - Image (Resolution, Size, Bit depth, Compression …)

- Types of fields /attributes
  - Mandatory (type 1- UIDs, study date, patient ID, …)
  - Optional (referring physician)
  - Private (info relevant for image post-processing)

DICOM header



Data Tag Element	16-bits unsigned representing Group and Element number.
Value Representation (VR)	2 bytes characters containing the VR of Data Element (e.g. string)
Value Length	- 16 or 32-bit (explicit or implicit) unsigned int containing length of the Value Field. - 32-bit length. Used for certain VR (SQ, UN, OW, OB)
Value Field	Even number of bytes containing the value(s) of Data Element

DICOM header: VR types

VR	Definition	Length	Sample
AS	Age string	4 bytes fixed	047Y
CS	Code string	16 bytes max.	MG
DA	Date string	8 bytes fixed	19930822
DS	Decimal string	16 bytes max.	44.8
LO	Long string	64 chars. max.	24X29
PN	Person Name	64 chars max	Simpson^Homer
SH	Short String	16 chars max.	H0711151700038
TM	Time	14 bytes max.	151850
UI	Unique Identifier	64 bytes max.	1.2.840.10008.1.2.1
US	Unsigned Short	2 bytes fixed	16

DICOM header: tags

Tag / ID	Keyword	VR	Sample
(0008,0020)	StudyDate	DA	20160711
(0008,0022)	AcquisitionDate	DA	20160711
(0008,0060)	Modality	CS	MG
(0010,0010)	PatientName	PN	XXXXX_J9EKL8218SO7CHGZ
(0010,0020)	PatientID	LO	XXXXX_HX3LCLOW32528JVC
(0019,1025)	<HOLOGIC, Inc.> [25]	SH	FAST
(0028,0010)	Rows	US	4096
(0028,011)	Columns	US	3328
(0028,0030)	PixelSpacing	DS	0.065238 / 0.065238
(0028,0100)	BitsAllocated	US	16

Sample DICOM headers

ID	Name	VR	Value
(0002,0000)	FileMetaInformationGroupLength	UL	202
(0002,0001)	FileMetaInformationVersion	OB	<2 Bytes>
(0002,0002)	MediaStorageSOPClassUID	UI	1.2.840.10008.5.1.4.1.1.1.2
(0002,0003)	MediaStorageSOPInstanceUID	UI	1.2.840.113681.168453826.1468221420.4100.100461
(0002,0010)	TransferSyntaxUID	UI	1.2.840.10008.1.2.1
(0002,0012)	ImplementationClassUID	UI	1.2.840.114089.1.0.0.3.3.12
(0002,0013)	ImplementationVersionName	SH	DCF 3.3.12c
(0002,0016)	SourceApplicationEntityTitle	AE	DCF
(0008,0005)	SpecificCharacterSet	CS	ISO_IR 100
(0008,0008)	ImageType	CS	DERIVED\PRIMARY
(0008,0014)	InstanceCreatorUID	UI	1.2.840.113681.168453826.1462380751.1448.1
(0008,0016)	SOPClassUID	UI	1.2.840.10008.5.1.4.1.1.1.2
(0008,0018)	SOPInstanceUID	UI	1.2.840.113681.168453826.1468221420.4100.100461
(0008,0020)	StudyDate	DA	20160711
(0008,0021)	SeriesDate	DA	20160711
(0008,0022)	AcquisitionDate	DA	20160711
(0008,0023)	ContentDate	DA	20160711
(0008,0030)	StudyTime	TM	151850
(0008,0031)	SeriesTime	TM	151959
(0008,0032)	AcquisitionTime	TM	151959
(0008,0033)	ContentTime	TM	151959
(0008,0050)	AccessionNumber	SH	XXXXX
(0008,0060)	Modality	CS	MG
(0008,0068)	PresentationIntentType	CS	FOR PRESENTATION
(0008,0070)	Manufacturer	LO	HOLOGIC, Inc.
(0008,0080)	InstitutionName	LO	UDIAT
(0008,0081)	InstitutionAddress	ST	Parc Tauli S/N
(0008,0090)	ReferringPhysicianName	PN	OFICINA TECNICA DE CRIBRATGE
(0008,1010)	StationName	SH	Dimensions
(0008,1030)	StudyDescription	LO	MAMOGRAFIA CRIBRATGE
(0008,1032)	ProcedureCodeSequence	SQ	
(0008,103e)	SeriesDescription	LO	L MLO
(0008,1040)	InstitutionalDepartmentName	LO	Mammography
(0008,1070)	OperatorsName	PN	Martin Almeida^Fany
(0008,1090)	ManufacturerModelName	LO	Selenia Dimensions
(0008,1110)	ReferencedStudySequence	SQ	

DICOM header: Technology comparison

Tag	Keyword	MG	MG	DBT	CT	MRI	ABUS
(0008,0060)	Modality						
(0008,0070)	Manufacturer						
(0018,0015)	BodyPartExamined						
(0018,0050)	Slice Thickness						
(0018,0060)	KVP						
(0018,0081)	EchoTime						
(0018,0088)	SpacingBetweenSlices						
(0018,1164)	ImagerPixelSpacing						
(0028,0008)	NumberOfFrames						
(0028,0010)	Rows						
(0028,0011)	Columns						
(0028,0030)	PixelSpacing						
(0028,0100)	BitsAllocated						

DICOM header: Technology comparison

Tag	Keyword	MG	MG	DBT	CT	MRI	ABUS
(0008,0060)	Modality	MG	MG				
(0008,0070)	Manufacturer	Hologic	GE				
(0018,0015)	BodyPartExamined	Breast	Breast				
(0018,0050)	Slice Thickness	-	-				
(0018,0060)	KVP	36	29				
(0018,0081)	EchoTime	-	-				
(0018,0088)	SpacingBetweenSlices						
(0018,1164)	ImagerPixelSpacing	-	0.0941				
(0028,0008)	NumberOfFrames	-	-				
(0028,0010)	Rows	4096	2294				
(0028,0011)	Columns	3328	1914				
(0028,0030)	PixelSpacing	0.0652	-				
(0028,0100)	BitsAllocated	16	16				

DICOM header: Technology comparison

Tag	Keyword	MG	MG	DBT	CT	MRI	ABUS
(0008,0060)	Modality	MG	MG	CT			
(0008,0070)	Manufacturer	Hologic	GE	Hologic			
(0018,0015)	BodyPartExamined	Breast	Breast	Breast			
(0018,0050)	Slice Thickness	-	-	1			
(0018,0060)	KVP	36	29	33			
(0018,0081)	EchoTime	-	-	-			
(0018,0088)	SpacingBetweenSlices						
(0018,1164)	ImagerPixelSpacing	-	0.0941				
(0028,0008)	NumberOfFrames	-	-	70			
(0028,0010)	Rows	4096	2294	2457			
(0028,0011)	Columns	3328	1914	1890			
(0028,0030)	PixelSpacing	0.0652	-	0.0868			
(0028,0100)	BitsAllocated	16	16	16			

DICOM header: Technology comparison

Tag	Keyword	MG	MG	DBT	CT	MRI	ABUS
(0008,0060)	Modality	MG	MG	CT	CT		
(0008,0070)	Manufacturer	Hologic	GE	Hologic	Koning		
(0018,0015)	BodyPartExamined	Breast	Breast	Breast			
(0018,0050)	Slice Thickness	-	-	1	0.273		
(0018,0060)	KVP	36	29	33	49		
(0018,0081)	EchoTime	-	-	-	-		
(0018,0088)	SpacingBetweenSlices						
(0018,1164)	ImagerPixelSpacing	-	0.0941				
(0028,0008)	NumberOfFrames	-	-	70	545		
(0028,0010)	Rows	4096	2294	2457	640		
(0028,0011)	Columns	3328	1914	1890	736		
(0028,0030)	PixelSpacing	0.0652	-	0.0868	0.273		
(0028,0100)	BitsAllocated	16	16	16	16		

DICOM header: Technology comparison

Tag	Keyword	MG	MG	DBT	CT	MRI	ABUS
(0008,0060)	Modality	MG	MG	CT	CT	MR	
(0008,0070)	Manufacturer	Hologic	GE	Hologic	Koning	Siemens	
(0018,0015)	BodyPartExamined	Breast	Breast	Breast		-	
(0018,0050)	Slice Thickness	-	-	1	0.273	1.300	
(0018,0060)	KVP	36	29	33	49	-	
(0018,0081)	EchoTime	-	-	-	-	-	
(0018,0088)	SpacingBetweenSlices					1.300	
(0018,1164)	ImagerPixelSpacing	-	0.0941			-	
(0028,0008)	NumberOfFrames	-	-	70	545	480	
(0028,0010)	Rows	4096	2294	2457	640	256	
(0028,0011)	Columns	3328	1914	1890	736	512	
(0028,0030)	PixelSpacing	0.0652	-	0.0868	0.273	0.664	
(0028,0100)	BitsAllocated	16	16	16	16	16	

DICOM header: Technology comparison

Tag	Keyword	MG	MG	DBT	CT	MRI	ABUS
(0008,0060)	Modality	MG	MG	CT	CT	MR	US
(0008,0070)	Manufacturer	Hologic	GE	Hologic	Koning	Siemens	-
(0018,0015)	BodyPartExamined	Breast	Breast	Breast		-	-
(0018,0050)	Slice Thickness	-	-	1	0.273	1.300	-
(0018,0060)	KVP	36	29	33	49	-	-
(0018,0081)	EchoTime	-	-	-	-	-	4
(0018,0088)	SpacingBetweenSlices					1.300	0.600
(0018,1164)	ImagerPixelSpacing	-	0.0941			-	0.600
(0028,0008)	NumberOfFrames	-	-	70	545	480	83
(0028,0010)	Rows	4096	2294	2457	640	256	278
(0028,0011)	Columns	3328	1914	1890	736	512	254
(0028,0030)	PixelSpacing	0.0652	-	0.0868	0.273	0.664	0.600
(0028,0100)	BitsAllocated	16	16	16	16	16	16

DICOM images

- **Image pixel intensity data:**

10011010011101001101100110000110101100110101011000
00110011110010110010101011110001010001100111000100
11001010100111001011110001000111010101000011010100
10010011100110100111010011011001100110000101110110
10010101011100110101100110101011000011001111001010
10010101001000110111010111100010100011001110001010
10010101001110010111100010001110101010000110101010
...

$2^8 = 256$ -> [0-255]

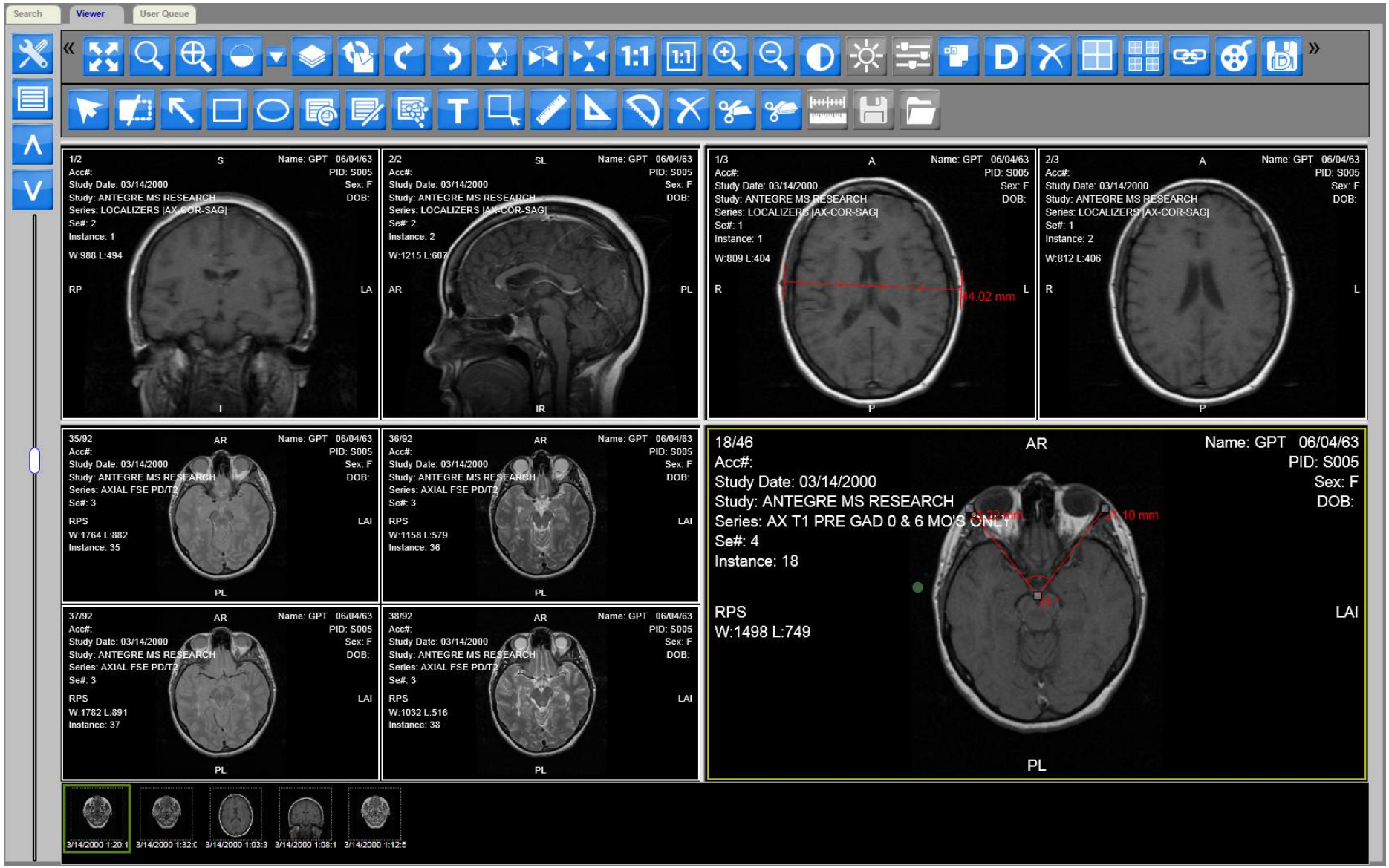
$2^{16} = 65,536$ -> [0-65,535]

DICOM images

- Can contain single DICOM objects (2D images) or multiple frames (3D/4D images)
- Pixel data can be compressed using:
  - JPEG
  - Lossless JPEG
  - JPEG 2000
  - Run-length encoding (RLE)
- Important tags: Bits Allocated, Bits Stored, High Bit.

- **DICOM grayscale standard display function (GSDF)**
  - Standard to display images using the same greyscale in different monitors or printers (GSDF curve)

DICOM viewer

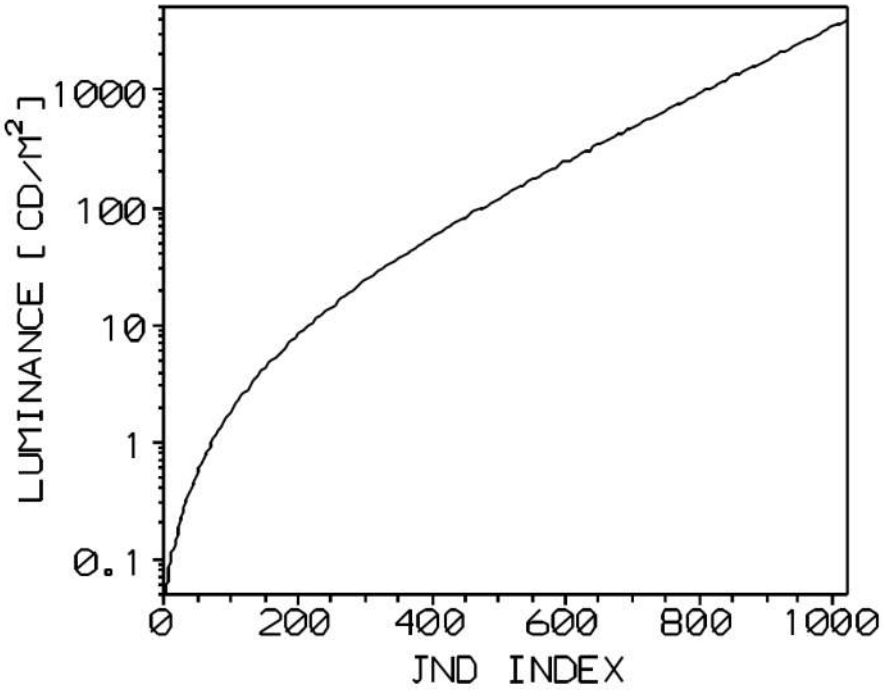


DICOM viewers

- OsiriX (not free!)
- Dicomworks
- MicroDicom
- JiveX DICOM Viewer
- 3DimViewer
- Navegatium DICOM Viewer
- Mango
- Escape
- IRFANVIEW
- RadiAnt
- HOROS

DICOM: Image display

- **DICOM grayscale standard display function (GSDF)**
  - Monitors should be calibrated according to DICOM requirements.
  - This ensures that the image perception is the same in different monitors.
  - Look up table to convert pixel values to monitor luminance values.



Just-noticeable difference (JND): is the amount something must be changed in order for a difference to be noticeable, detectable at least half the time. (Source: Wikipedia).

IHE

IHE

- Acronym for **I**ntegrating the **H**elthcare **E**nterprise.
- Coordinated by Radiological Society of North America (RSNA)

https://www.ihe.net/

- Consortium of healthcare professionals and industry partners to **improve interconnection and information exchange between healthcare systems**.
- IHE **promotes the coordinated use of established standards such as DICOM and HL7** to address specific clinical needs in support of optimal patient care.

IHE

- **Vision**: Enables uninterrupted and secure access anytime and anywhere to useful health information.
- **Mission**: Provides specifications, tools and services for interoperability. Healthcare professionals develop, test, and implement standards-based solutions to vital health information needs
- **Goal**: IHE improves efficiency and effectiveness of clinical practice:
  - Improve workflow
  - Improve information accuracy
  - Improve information availability
  - Enable cross-system functionality

Healthcare areas using IHE

- Anatomic Pathology
- Cardiology
- Dental
- Eye Care
- IT Infrastructure
- Laboratory
- Patient Care Coordination
- Patient Care Devices
- Pharmacy
- Quality, Research and Public Health
- Radiation Oncology
- Radiology
- Mammography
- Nuclear Medicine

- IHE creates information resources and tools for healthcare vendors and users:
  - Integration Profiles
  - Technical Frameworks
  - User Handbooks
  - Public Comments
  - Case Studies
  - Webinars

IHE Profiles

- IHE Profiles **describe clinical information management** and **specify how to use existing standards** (HL7, FHIR, IETF, DICOM, OASIS, ISO, etc.) to address them.
- Systems that implement integration profiles **solve interoperability problems**.
- For equipment vendors:
  - Integration Profiles are implementation guides.
- For healthcare providers:
  - Integration Profiles contain key information for integration requirements in purchasing documents.

IHE: Clinical examples

- Examples:
  - DICOM allows different image formats. Some might comply with the optional fields but not accepted by a given application. **IHE reduces the chances of incompatibilities.**
  - Current and prior images with different pixel sizes. **IHE should help to scale the largest breast to fit the screen.**
  - **Limit the amount of header information displayed on screen.**

PACS

PACS

PACS

- Acronym for **P**icture **A**chieving and **C**ommunication **S**ystem.
- Developed in the 80s.

- Healthcare technology for short- and long- term:
  - Data storage
  - Data retrieval
  - Diagnosis management
  - Data distribution
  - Display of medical images and related information

- **Query criteria**: patient ID, medical record number or accession number

Definitions

PACS can interact with other hospital system:

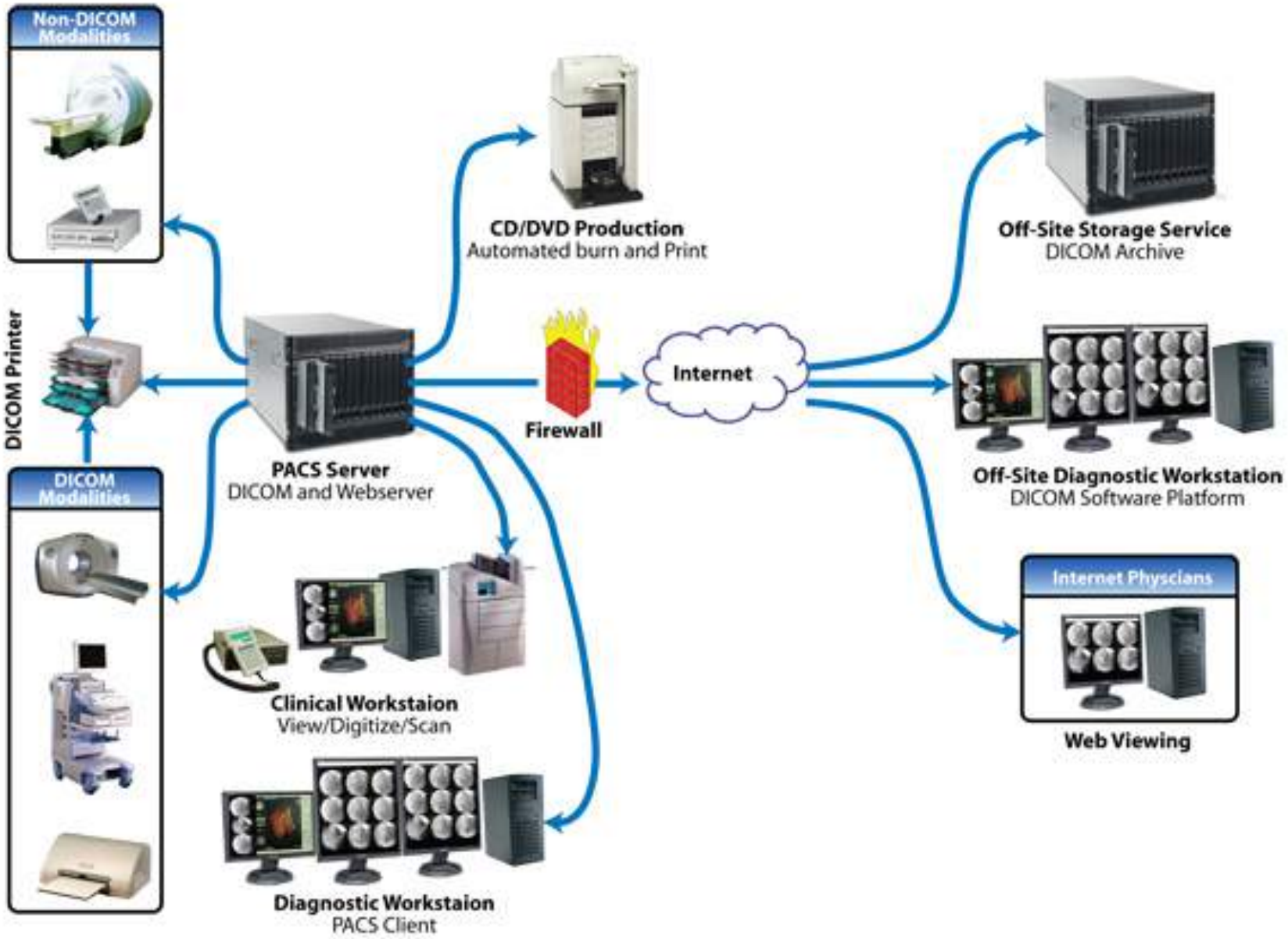
- **Radiology Information Systems (RIS):**
  - System for managing medical images and associated data (scheduling, results reporting, billing, etc.)
- **Hospital Information System (HIS):**
  - Integrated information system to manage all medical, administrative, financial and legal issues in hospitals.

- PACS uses the most common standards (DICOM, HL7) to improve compatibility of new image modalities.

PACS structure

- **PACS central server**: core of the system.
- **PACS Workstation**: display of digital images to PACS viewer.
- **Database system**: storage of all information and images.
- **DICOM server**: management of all DICOM-based communications.
- **Storage system**: physical storage to storage DICOM images.
- **Interface to RIS/HIS**: aggregates all patient data from different departments and provides end-to-end patient care workflow.
- **Web server** for remote Access using internet browsers/SFTP.

PACS: structure overview



Taken from http://www.radiology-syria.com/

Clinical environments

- Large hospitals, develop or outsource PACS.
- Usually, small clinics use web-based interfaces.
- Clients connect remotely over Virtual Private Networks (VPN) or Secure Web Site (HTTPS)

PACS: advantages

- Increases productivity of radiologists.
- Reduction of cost of radiology.
- Reduction of storage space (no need for CD or hardcopy).
- Faster and more reliable access to prior images.
- Access to images from anywhere (remote access).
- Improve training/teaching.

Before you go….

Example of the digital hospital: radiologist's workstation.

Before you go….

Well, maybe this has gone too digital!!!


THANK YOU
FOR STAYING AWAKE
MATT GROENING

More of these topics soon…

Josep Fernández

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Corporació Sanitaria Parc Taulí (Sabadell)

- **RAIM sever**: stores and manages digital medical images.
- **GRAPES Viewer**: medical image viewer.
- **RAIM SDI**: management software

More information at: https://www.tauli.cat/udiat/cimd-presentacio

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The digital hospital

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