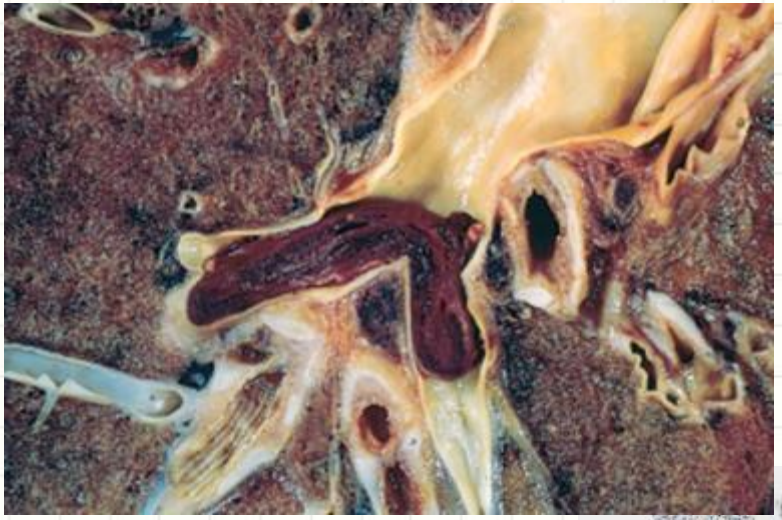
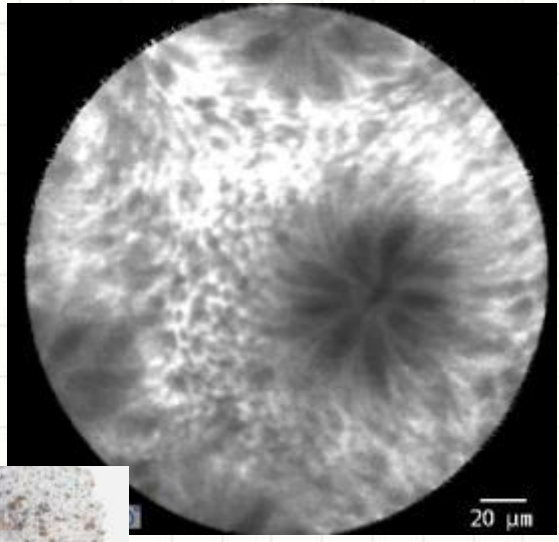
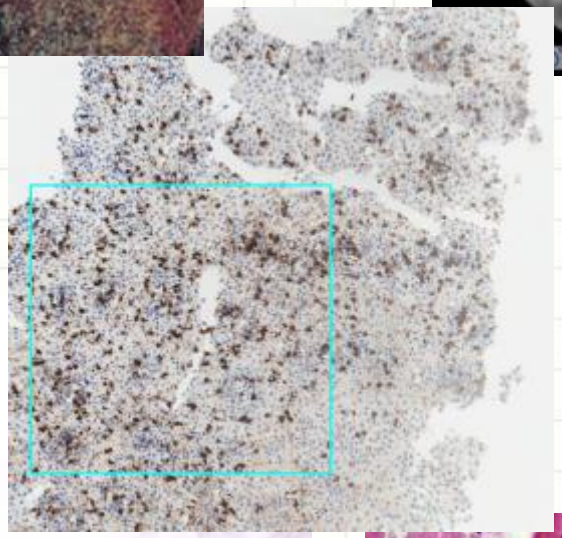
STANDARDISATION IN DIGITAL PATHOLOGY

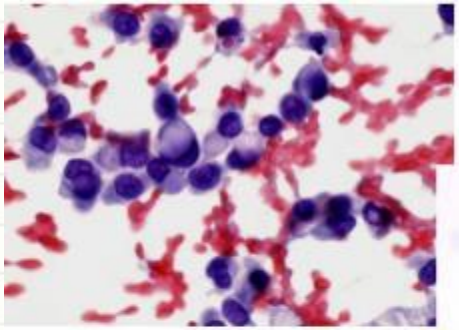
Marcial García Rojo
Hospital de Jerez. Cádiz. España
Vice-President
Spanish Society for Health Informatics

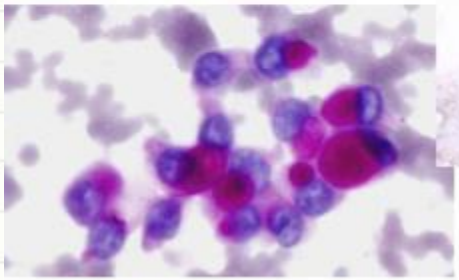
Multiple image sources

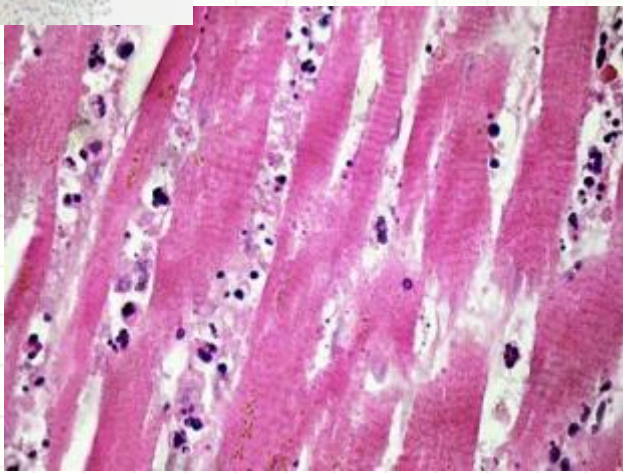




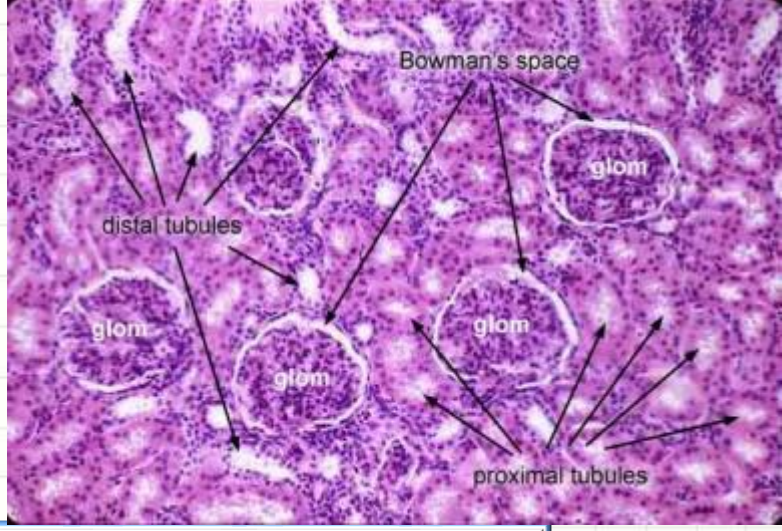






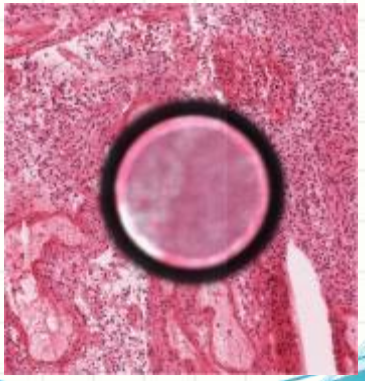


Introduction

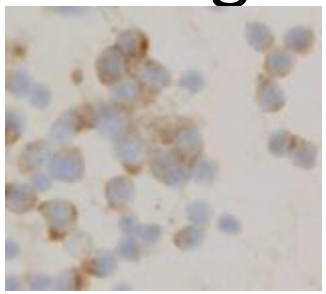


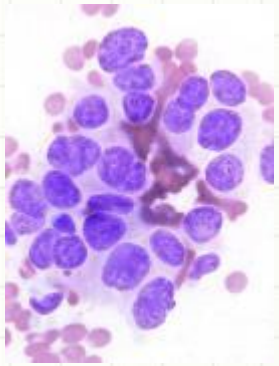
- **Digital imaging** in pathology can significantly **improve workflow**, hence increasing **productivity** while reducing **costs**, enable automated **image analysis**, quantification and **quality** control.
- However, the **efficient use of digital slide** systems is still a challenge.

Main challenges

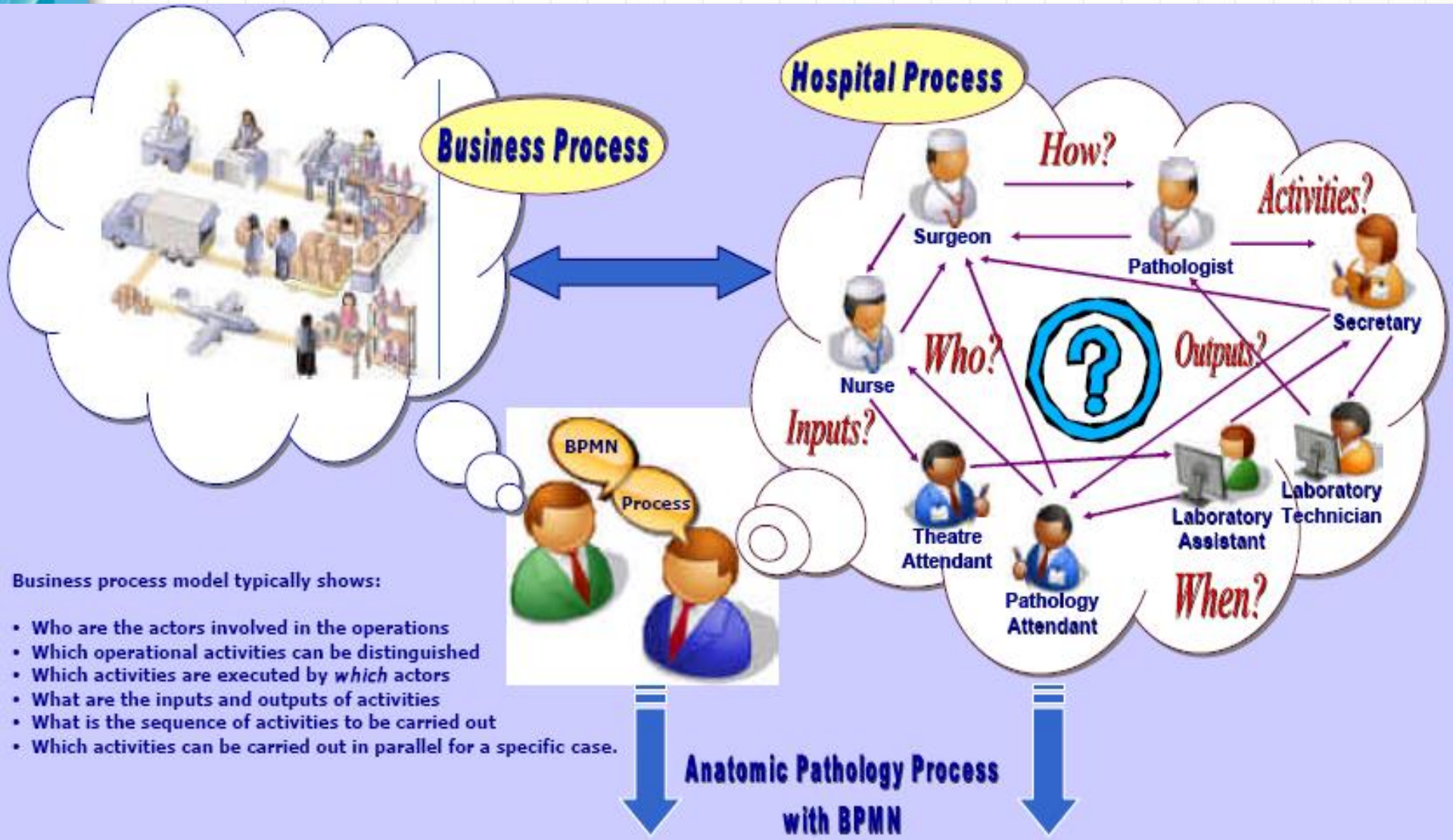


- Size of pathology microscopic images
- Scanning speed
- Image quality
- Proprietary image formats
- Efficiency of automated image analysis
- Specimen-based image management
- Lack of experience

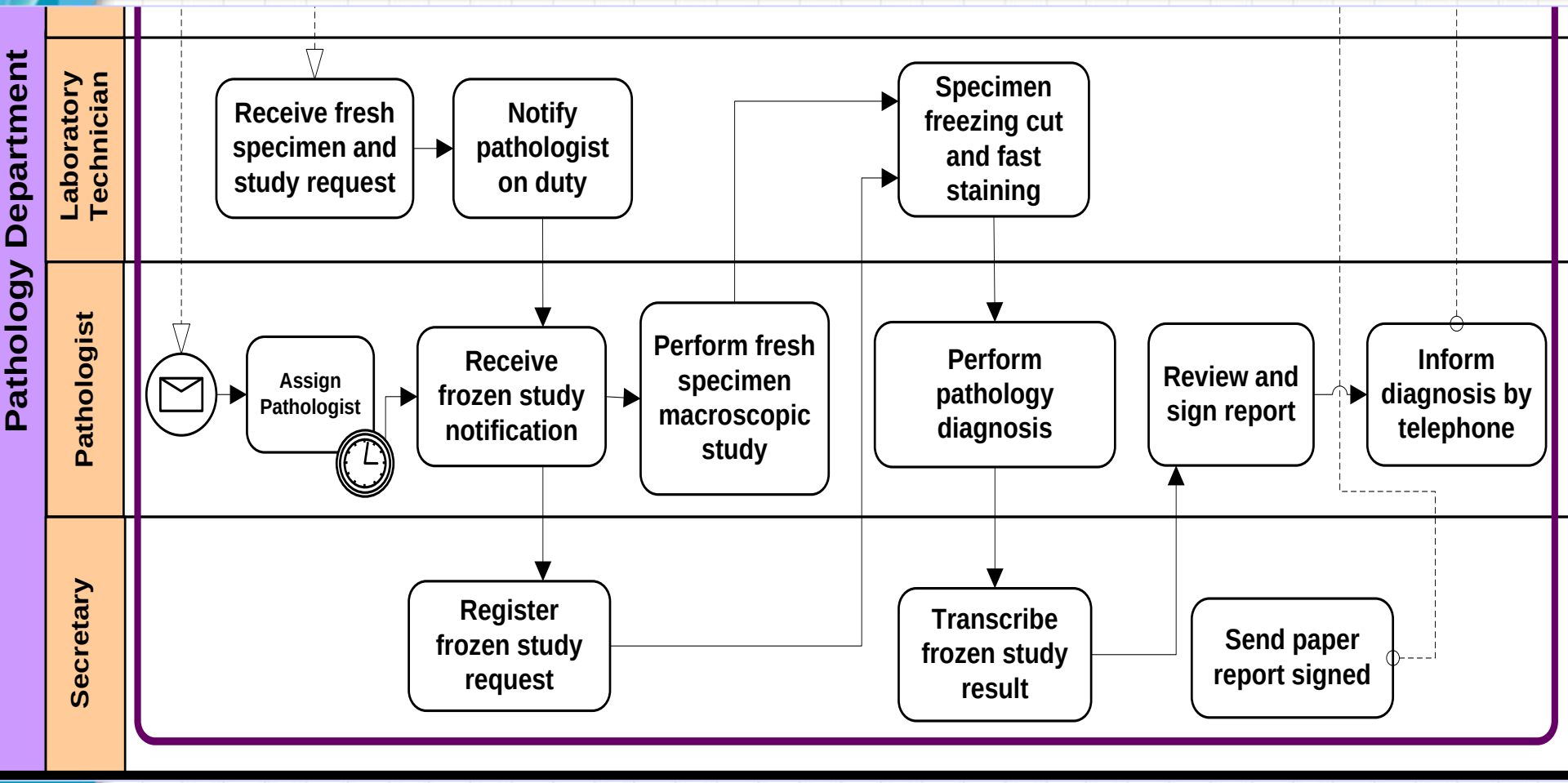




Hospital processes

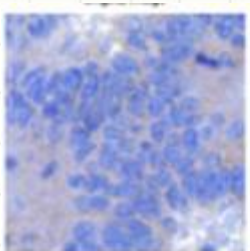
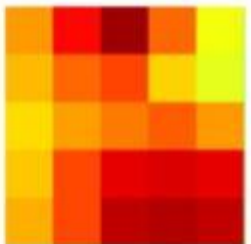
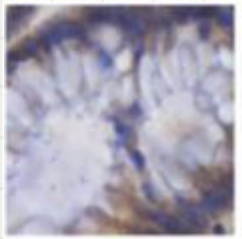


BPMN


Pathology Department
Laboratory Technician
Pathologist
Secretary
Receive fresh specimen and study request
Notify pathologist on duty
Specimen freezing cut and fast staining
Assign Pathologist
Receive frozen study notification
Perform fresh specimen macroscopic study
Perform pathology diagnosis
Review and sign report
Inform diagnosis by telephone
Register frozen study request
Transcribe frozen study result
Send paper report signed

Technical solutions

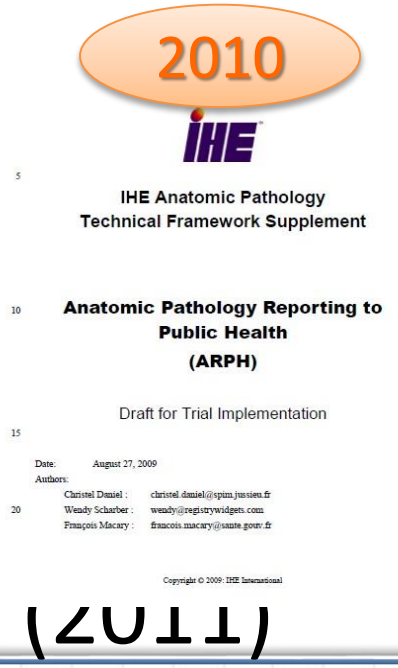
- **Parallelizing techniques** for image processing and analysis can be applied using parallel computing architectures of distributed memory with massive parallel processors
- **Cloud technology** is also considered a good alternative to store and share large digital images with secured access
- International **standards**

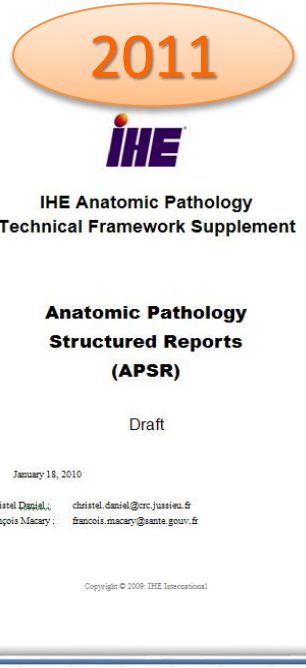





IHE: Integrating Healthcare Enterprise

A framework to understand standards

IH





(2011)

```
MSH | ^~\& | ADT1 | MCM | LABADT | MCM | 198808181126 | SECURITY | ADT^A01 | MSG00001- | P | 2.4
EVN | A01 | 198808181123
PID | | | PATID1234^5^M11 | | JONES^WILLIAM^A^III | | 19610615 | M- | | C
PV1 | 1 | I | 2000^2012^01 | | | | 004777^LEBAUER^SIDNEY^J. | | | SUR | | -| | ADM | A0
AL1 | 1 | | ^PENICILLIN | | PRODUCES HIVES~RASH~LOSS OF APPETITE
DG1 | 001 | I9 | 1550 | MAL NEO LIVER, PRIMARY | 19880501103005 | F
PR1 | 2234 | M11 | 111^CODE151 | COMMON PROCEDURES |
```

Segments identify the type of information that appears in the message.
This HL7 message contains the following segments:

MSH	message header
EVN	event type
PID	patient identification
PV1	patient visit information
AL1	patient allergy information
DG1	diagnosis
PR1	procedures

mTuitive
Just Add Knowledge

Health Level 7 HL7

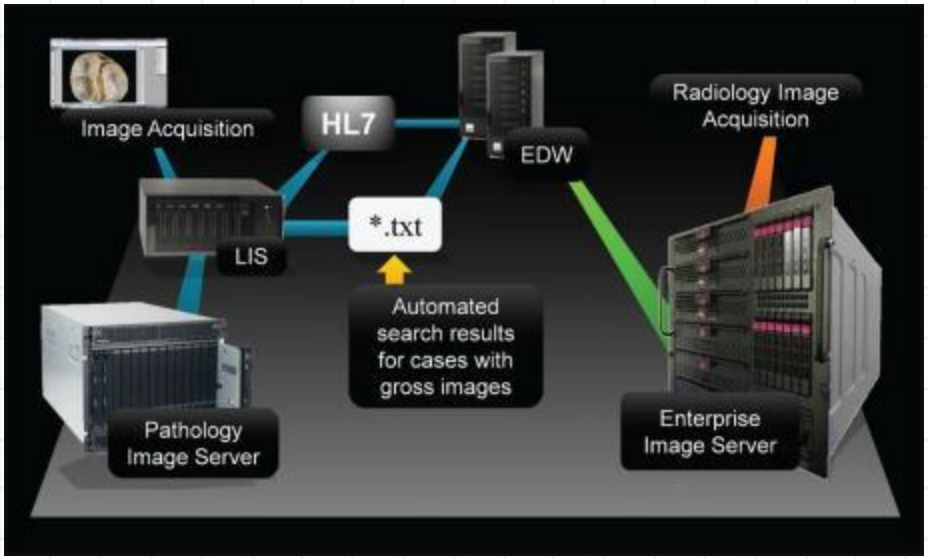
Messaging between applications
Also essential in image management
Universal object identification
Clinical Document Architecture (CDA)
LIS integration

Why IHE AP is needed

How to use HL-7 and DICOM **Pathology general workflow**

Excellent guide for IT professionals to implement digital pathology **Interoperability solution** for Pathology information system, electronic health record, PACS and image viewer

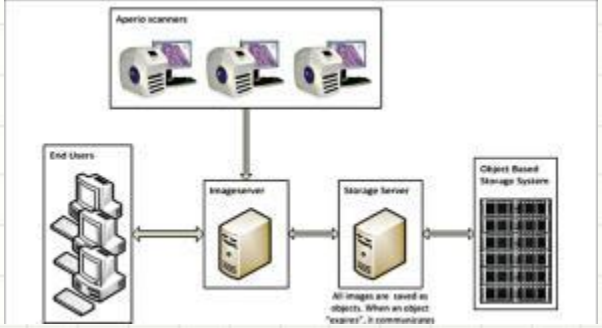
Practical solutions



Pantanowitz et al

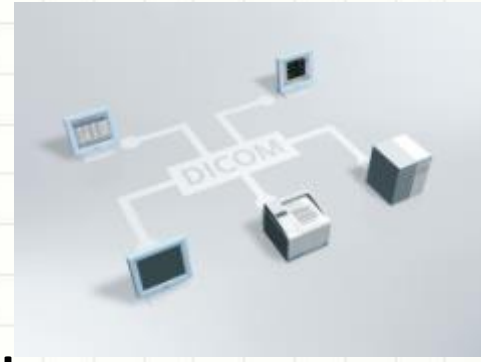
- Systems are able to read main proprietary formats
- Vendors give others image exchange information (difficult to be updated)
- “Vendor neutral solutions”: VNA

PACS and DICOM



- In order different modalities to work together (TCP-IP network), we need a common protocol: DICOM, which:
  - Assign **roles** to each system (send, receive,…)
  - Define which **messages** (information) must be exchanged:
    - Modality Worklist (MWL)
    - Modality Performed Procedure Step (MPPS)
    - Storage Commitment (STC)

Why DICOM?



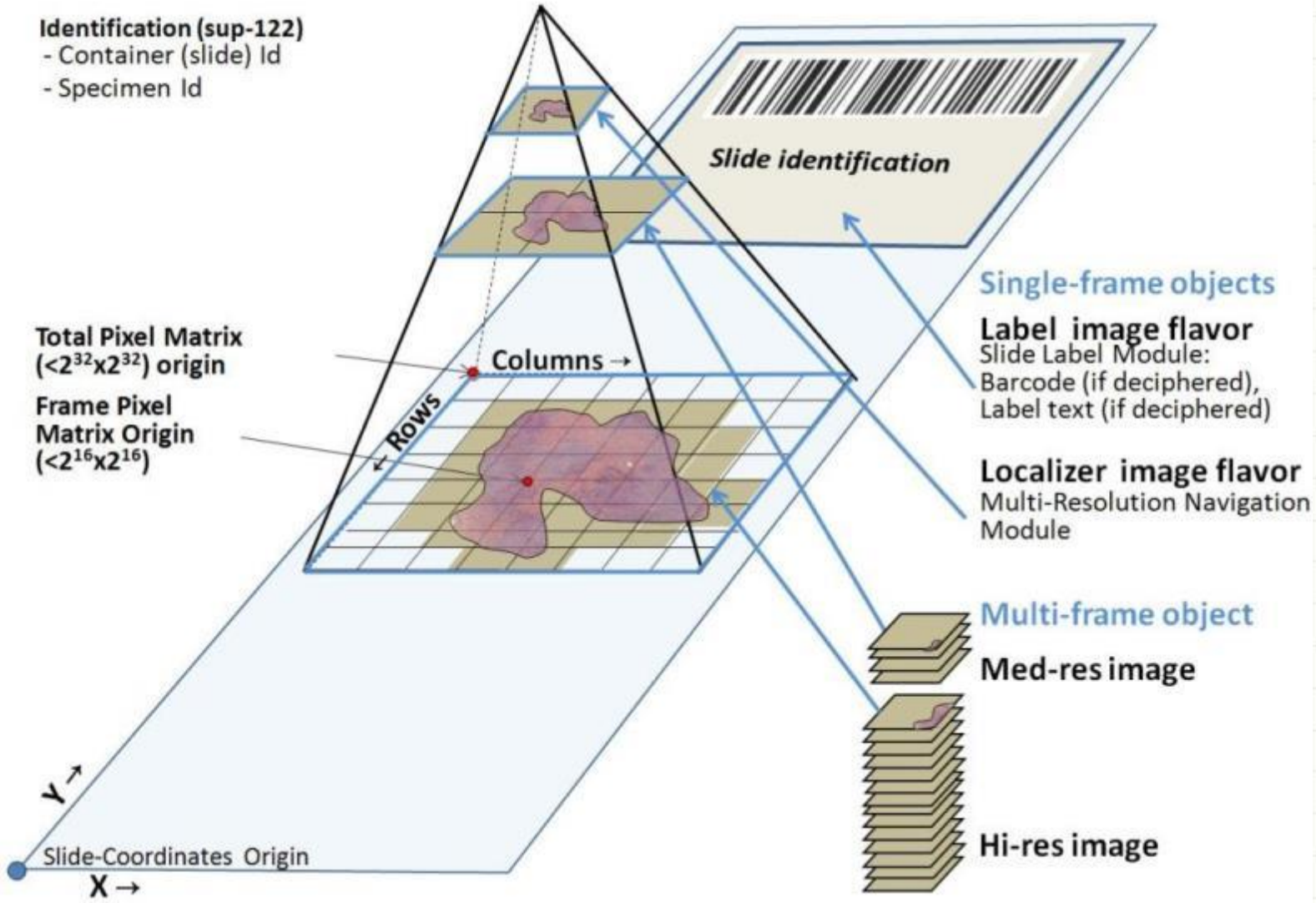
Excellent **results** in Radiology

Direct use in “small images”: gross images

Main **changes** in DICOM for pathology large images:

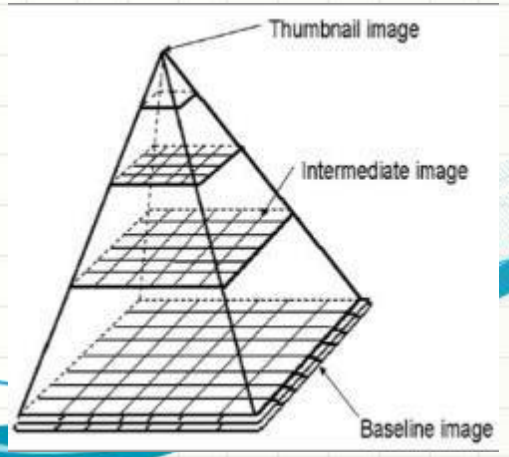
- **Specimen**, not patient-driven
- Large images cannot be directly saved (rows/columns **limit**) → split into series

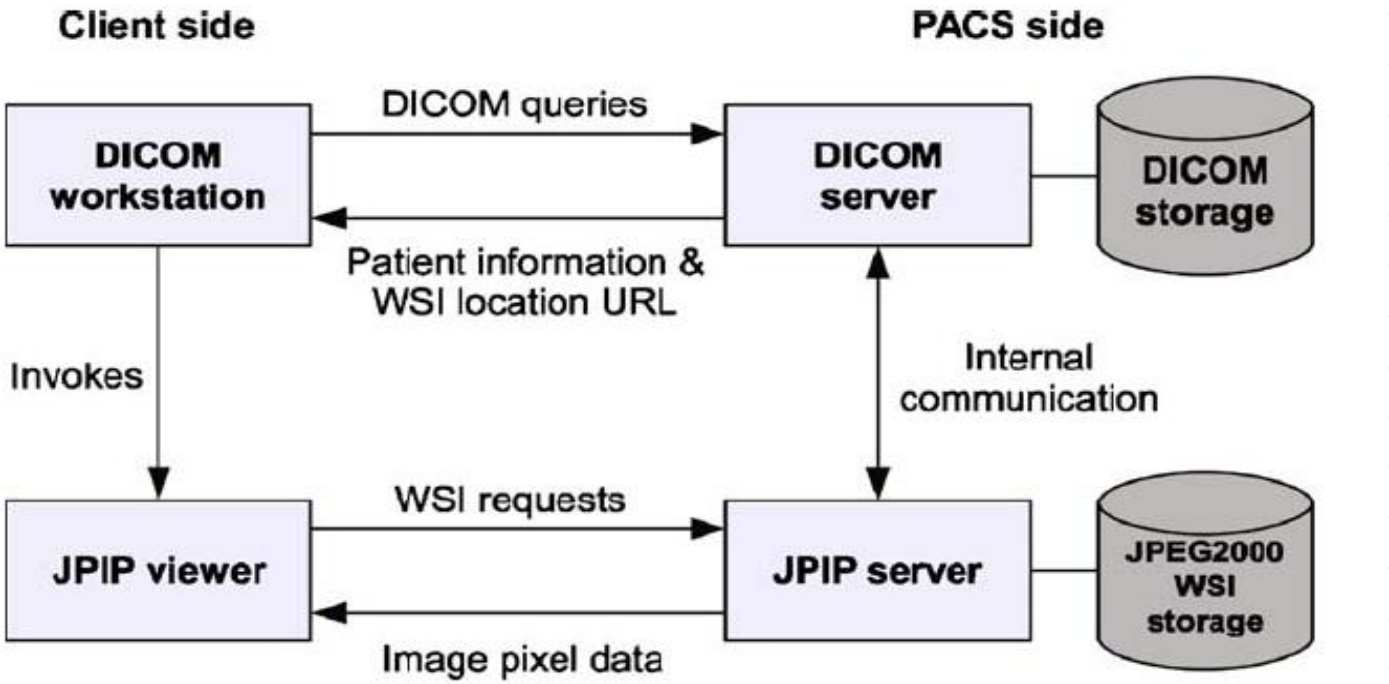
DICOM Sup 122 & 145



JPEG2000/JPIP

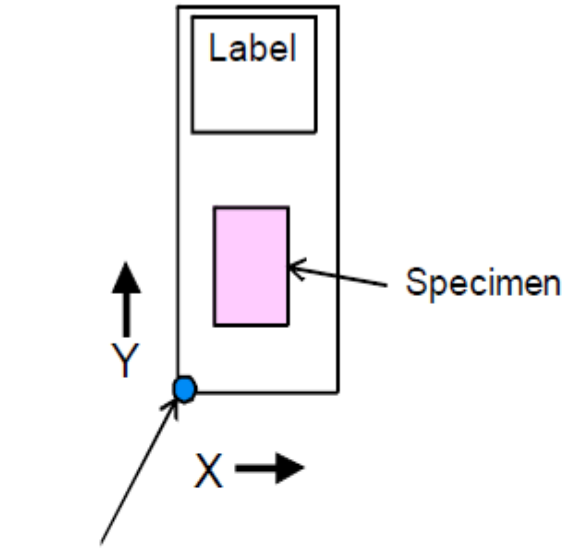
Tuominen VJ, Isola J. **Linking whole-slide microscope images with DICOM by using JPEG2000 Interactive Protocol**. J Digit Imaging. 2010 Aug;23(4):454-62.

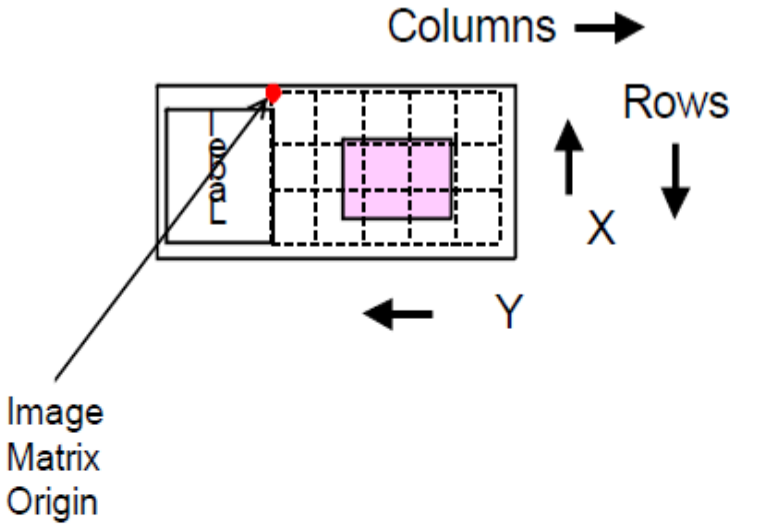


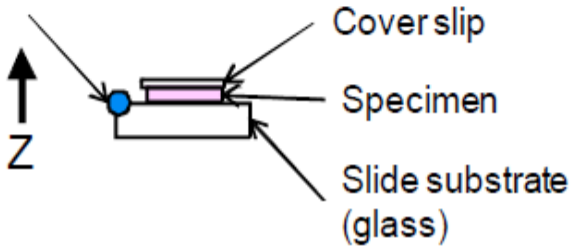


DICOM

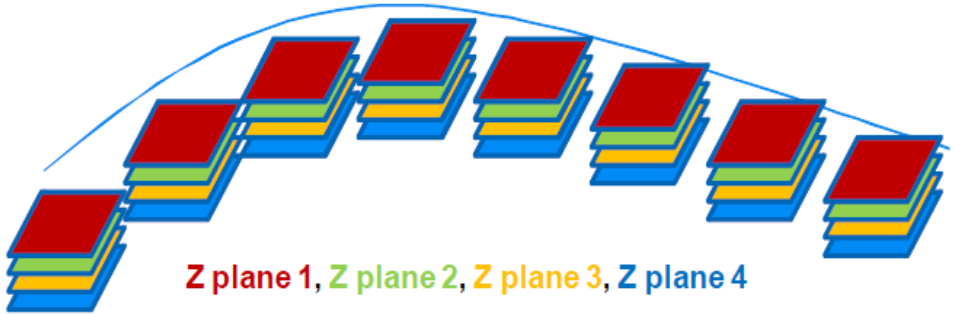
Slide-based coordinate system







Z-plane, is identified as the nominal physical height (in µm) of image focus above the glass

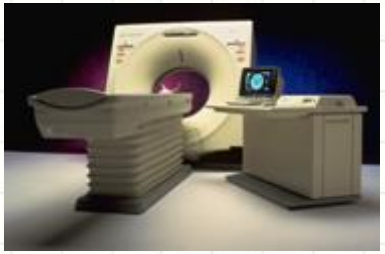


Information Object Definitions (IOD) in Pathology

- Visible Light (VL) **photographic image** (gross pictures)
- VL **Microscopic** Image IOD (microscopic static images)
- VL Slide-**Coordinates** Microscopic Image IOD (static images coordinates)
- VL **Whole Slide** Microscopy IOD

A DICOM services example
Client and Server roles

CT Scan Modality

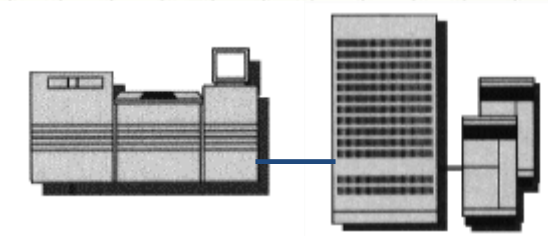


SCU storage

I ask this CT scan study

to be saved

PACS Archive



SCP storage

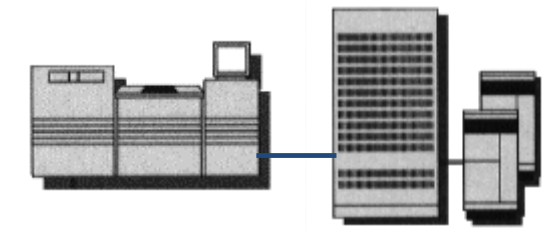
Virtual Slide Modality

SCU storage

I ask these slides

to be saved

PACS Archive



SCP storage

SCU: Service Class User

SCP: Service Class Provider

DICOM and Pathology

- Supplement 122 (in 2008). DICCOM **Specimen** module attributes is defined → All IOD modules had to add the “Specimen” module
- Supplement 145 (in 2010). Managing digital slides: Defining WSI IOD and “tiling” concept (fragment image)
- Supplements 61 and 105 (JPEG2000) and 106 (JPIP). Implemented in 2005 in SESCAM, Spain
- DICOM does not include recommendation about file formats in WSI.

Important message!

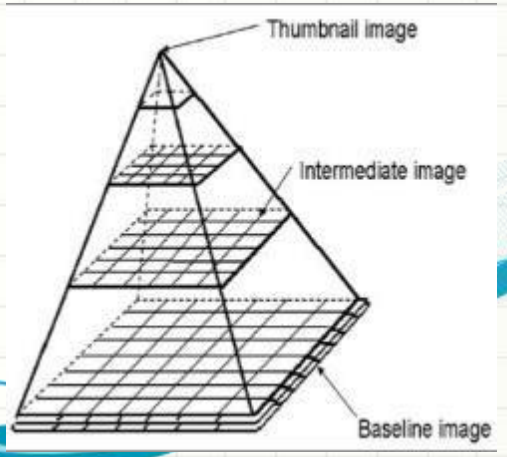
- **Ole Eichhorn (2011):** Many people don't realize that DICOM supp 145 is a *messaging standard*, not a *file standard*; it did not establish a common standard format for storing whole-slide imaging for pathology (WSI). Instead, it established a standard for the **exchange of WSI** information between systems, for the purpose of storing, retrieving, displaying, analyzing, etc. such images.

DICOM. New image circuits

- “A slide is going to be scanned”. Convert pathology information system data (patient, topography, accession number, staining, magnification, are to be scanned) in DICOM services: HL7 messages →
  a) Formatted to DICOM “worklist” and
  b) It is planned (“scheduling”)

What's next with DICOM

Storing and retrieving large images via dicom
US 20120099769 A1Owner name: LEICA BIOSYSTEMS IMAGING, INC., CALIFORNIA



- Leica patent (storing and retrieving large images via DICOM US 20120099769 A1) can be used by other companies
- Multiple image formats in virtual microscopy (whole slide imaging)
- Agreement of compression. Lossless algorithms (Radiology)?

Conclusions

1. Imaging standards have been developed but still need to be tested in real situations
2. Confusion about patents are preventing some standards to be implemented
3. A European guide for digital pathology including IT standards

QUESTIONS?

marcial@seis.es