

Pathology + DICOM: A Picture-Perfect Pairing

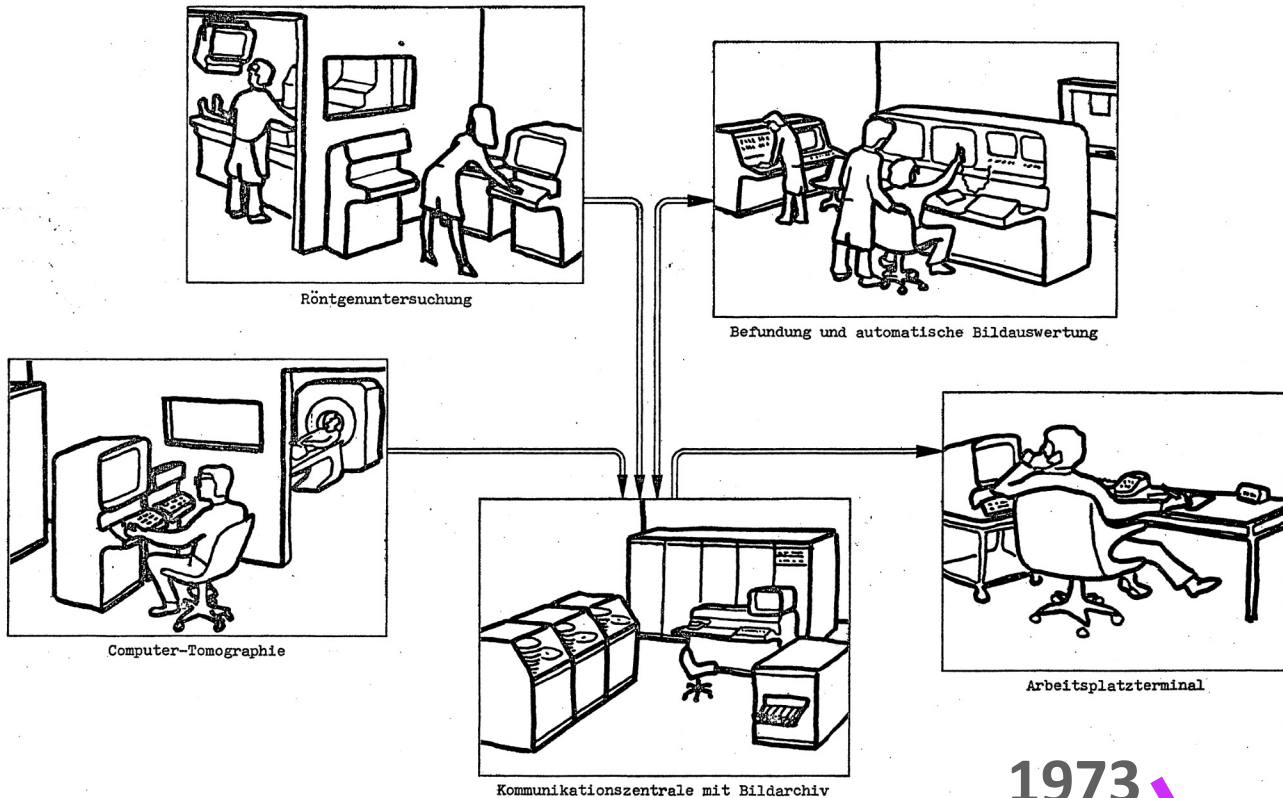
David Clunie, PixelMed

Disclosures

- Editor of the DICOM Standard (NEMA contract)
- NCI FNL Leidos Essex sub-contractor (SME DICOM, de-identification)
- NCI Imaging Data Commons (IDC) sub-contractor
- Consult with various equipment manufacturers regarding DICOM

Overview

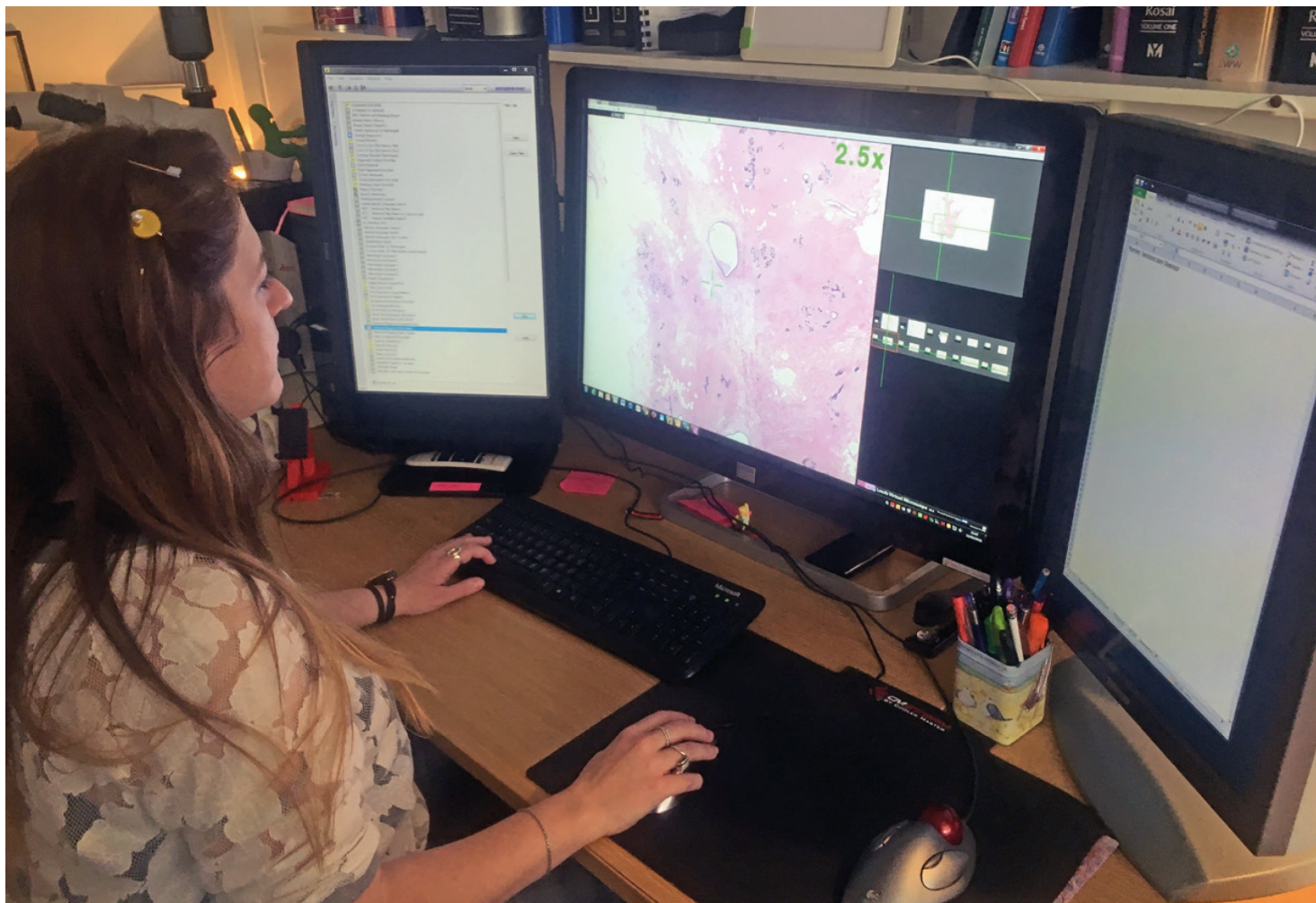
- Transition from optical to digital
- Whole slide imaging versus photo-microscopy
- Industrialization of the digital process
- Really big images – tiled pyramids, virtual microscopy
- Proprietary formats vs. interoperability (i.e., DICOM)
- Encoding tiled pyramids as DICOM enhanced multi-frame images
- Use of DICOMweb as API to find, retrieve, navigate tiles (frames)
- Workflow and metadata different from radiology
- IHE Digital Pathology Image Acquisition (DPIA) HL7V2, DICOM profile
- Color management
- Annotations (esp. for AI)



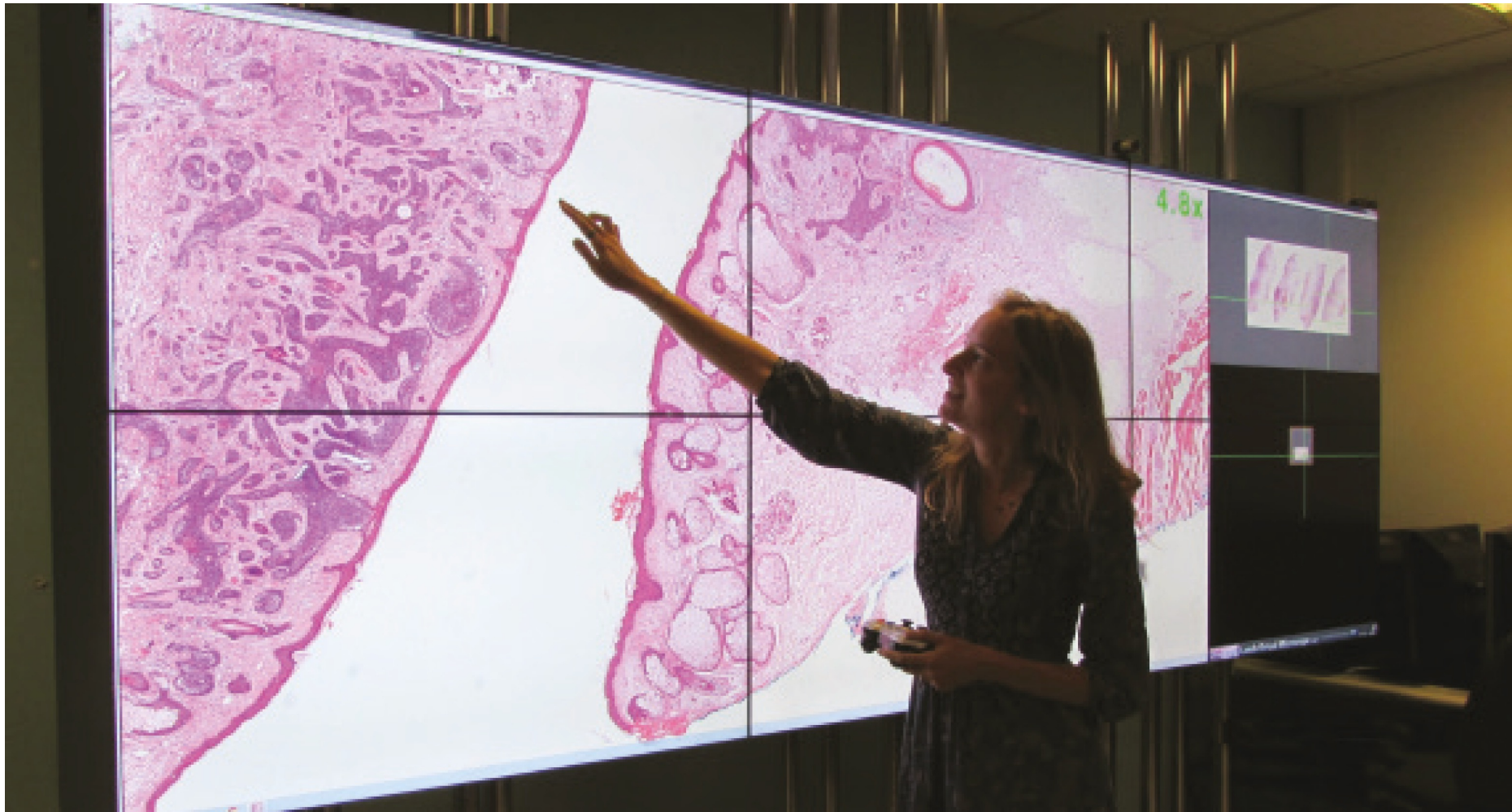
Meyer-Ebrecht D. [Electronic Archival System for X-Rays Images - Work proposal for a research project in the years 1974 and 1975] Elektronisches Archivierungssystem für Röntgenbilder – Arbeitsvorschlag für ein Forschungsprojekt in den Jahren 1974 und 1975. Hamburg, Germany: Philips Research Labs; 1973 Oct.



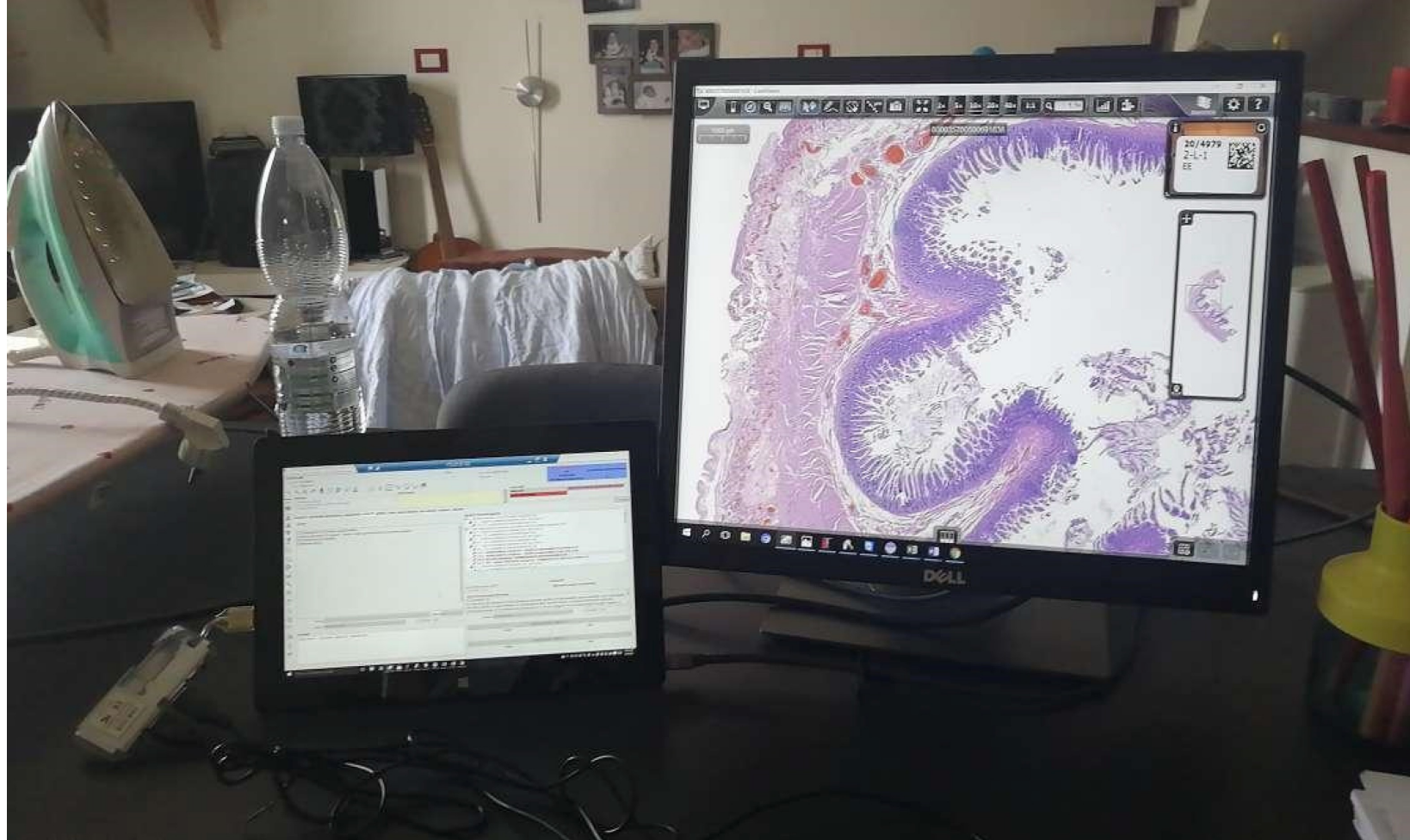
<http://www.med.unic.ac.cy/2016/02/07/histopathology-laboratory/>



<http://www.leicabiosystems.com/en-gb/knowledge-pathway/the-leeds-guide-to-digital-pathology/>



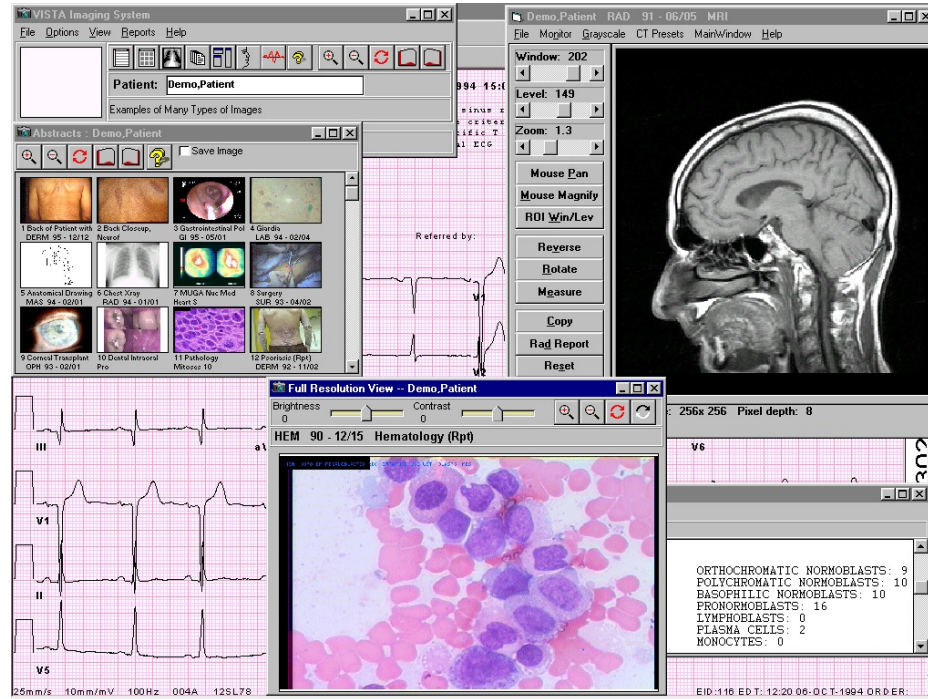
<http://www.leicabiosystems.com/en-gb/knowledge-pathway/the-leeds-guide-to-digital-pathology/>



Fraggetta et al. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC8534326/>

Digital Pathology & Microscopy have long been part of Enterprise Imaging

Cardiology
Bronchoscopy
Gastrointestinal
Endoscopy
Hematology
Pathology
Surgery
Nuclear Medicine
Dental
Radiology
Dermatology
Ophthalmology
Podiatry
Vascular
Urology
Nursing
Electrocardiography
Scanned Documents





<http://www.olympus-lifescience.com/en/applications/manual-whole-slide-imaging/>



<http://www.olympus-lifescience.com/en/applications/manual-whole-slide-imaging/>

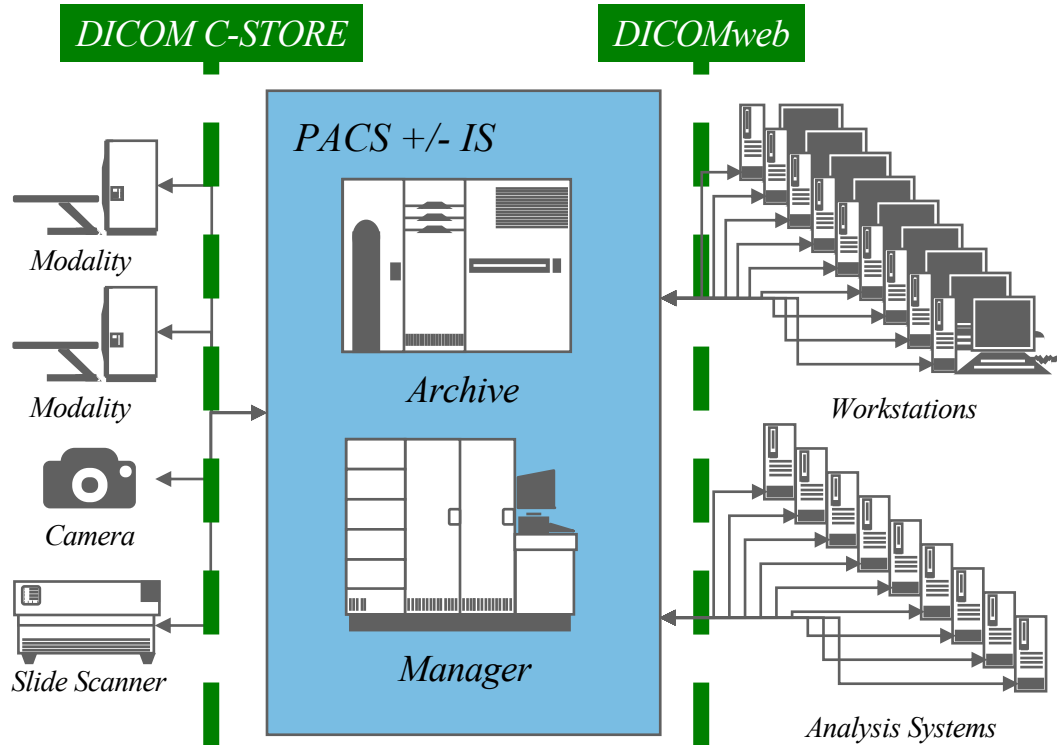


<http://www.3dhitech.com/3-steps-to-ensure-superior-image-quality-with-digital-slide-scanning/>

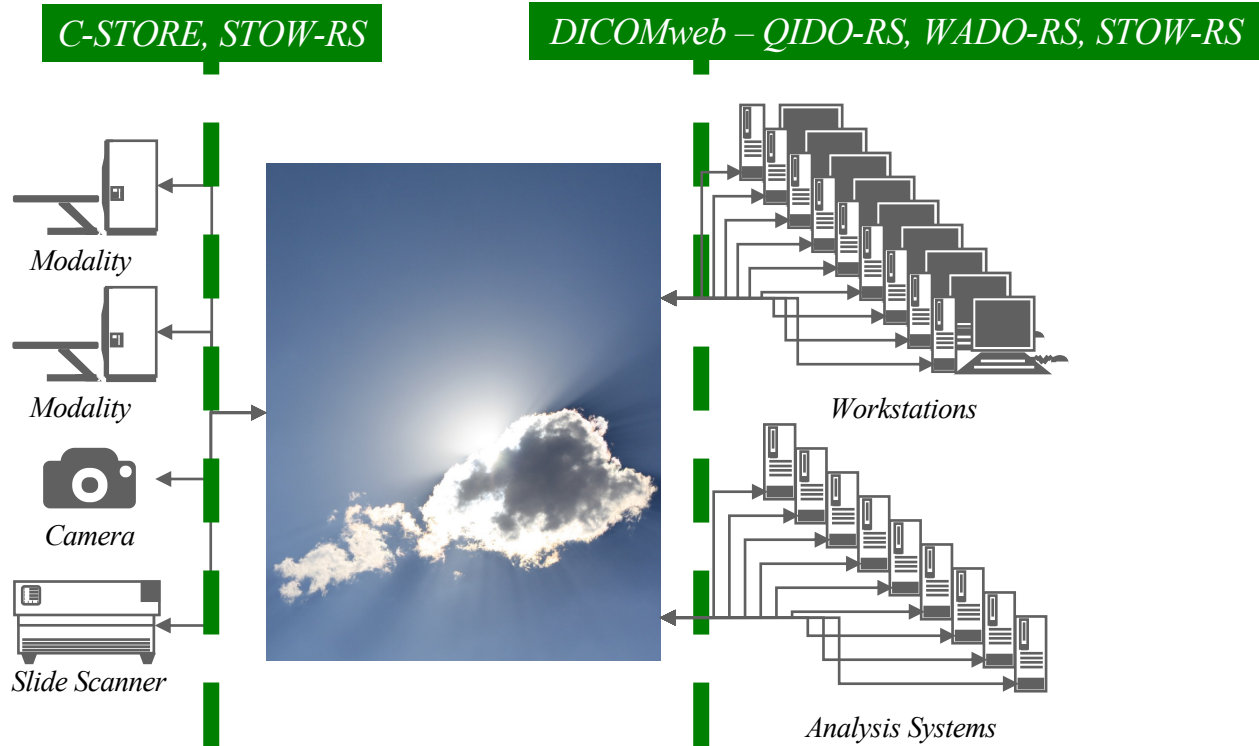


http://www.youtube.com/watch?v=p2GI0fN_sr4

DICOM – Enterprise Imaging – All Modalities



DICOM – Enterprise Imaging on the Cloud for All Modalities





Clifford's
Really **Big** Movie

Search Google Maps



Sign In



Layers

Google

Search Google Maps



Restaurants

Hotels

Things to do

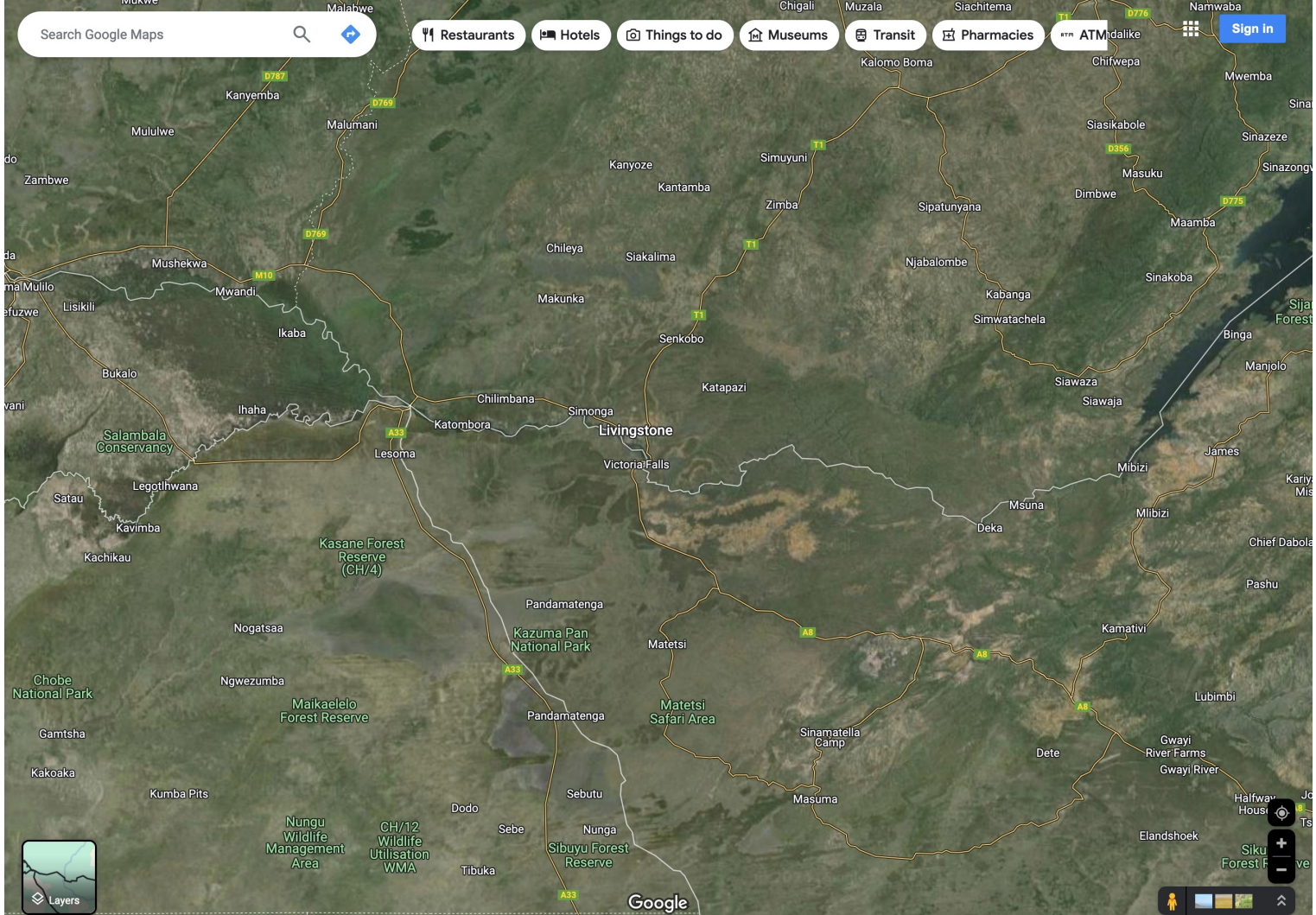
Museums

Transit

Pharmacies

ATM

Sign in



Layers

Google

Search Google Maps



Restaurants

Hotels

Things to do

Museums

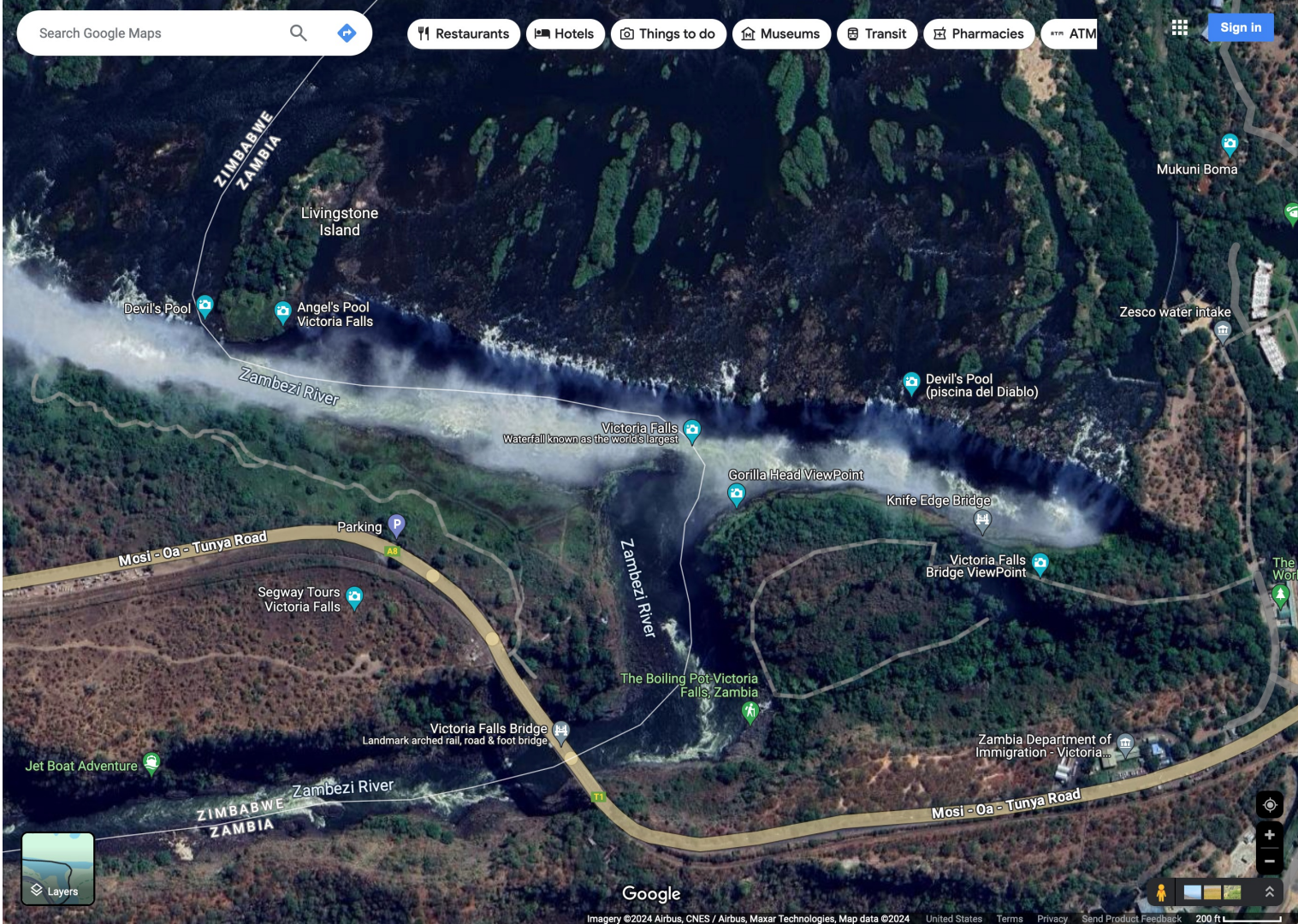
Transit

Pharmacies

ATM



Sign in



ZIMBABWE
ZAMBIA

Livingstone Island

Devil's Pool

Angel's Pool
Victoria Falls

Zambezi River

Victoria Falls
Waterfall known as the world's largest

Gorilla Head ViewPoint

Knife Edge Bridge

Victoria Falls
Bridge ViewPoint

Zambezi River

Mosi - Oa - Tunya Road

Parking

Segway Tours
Victoria Falls

The Boiling Pot: Victoria Falls, Zambia

Victoria Falls Bridge
Landmark arched rail, road & foot bridge

Zambia Department of Immigration - Victoria...

Jet Boat Adventure

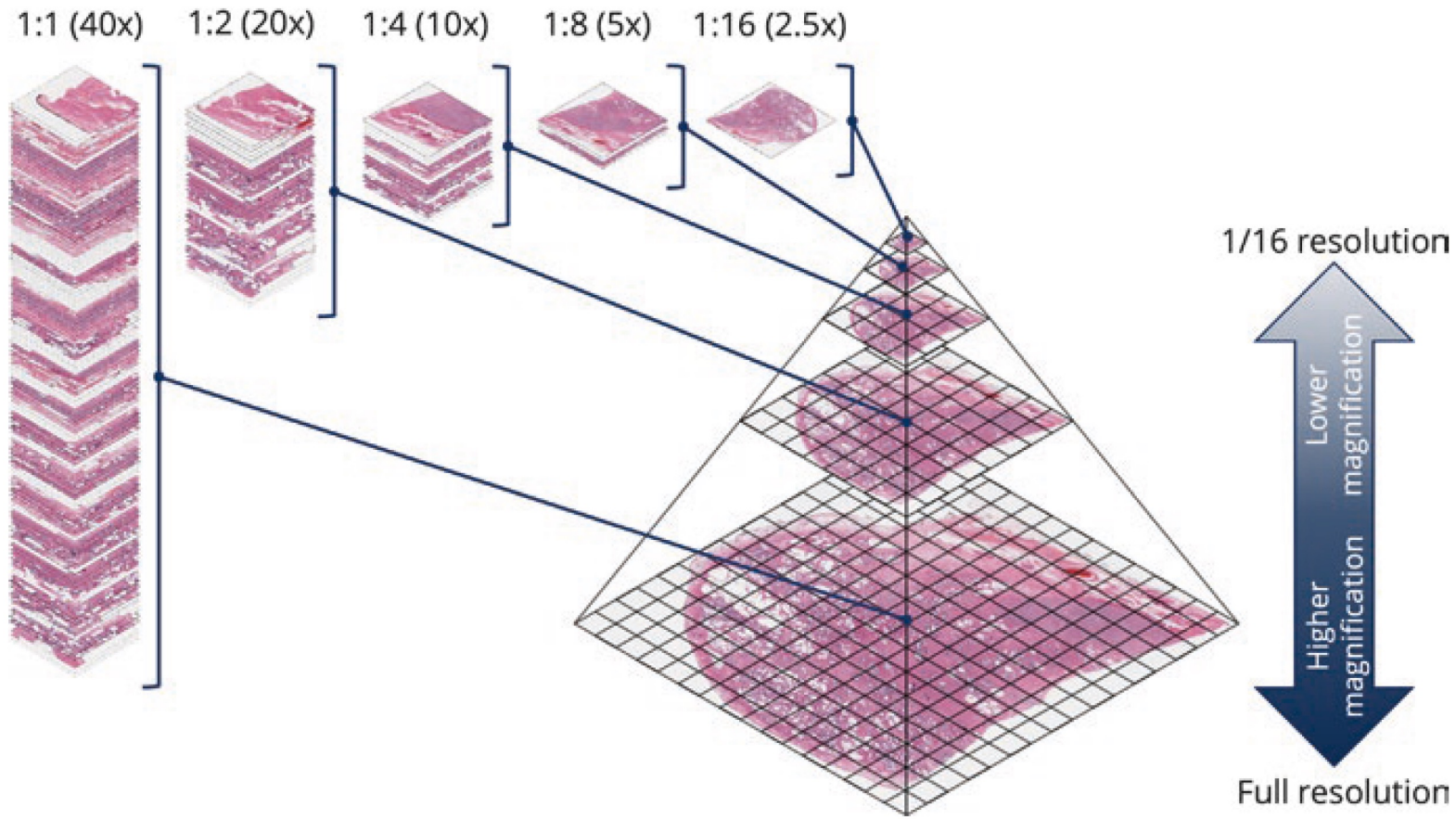
Zambezi River

ZIMBABWE
ZAMBIA

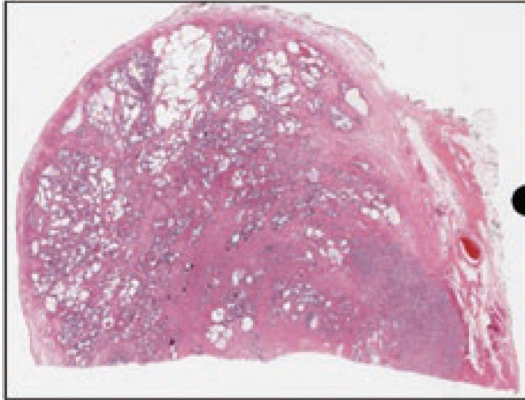
Mosi - Oa - Tunya Road



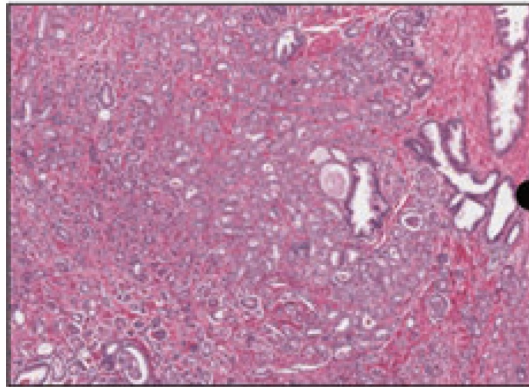
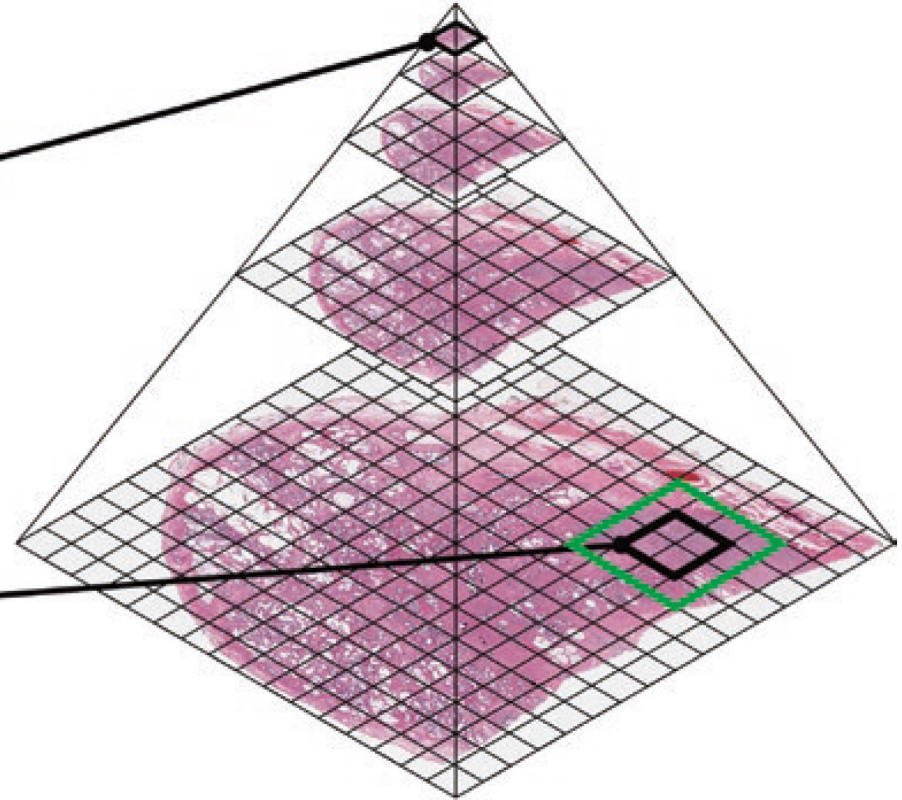
Google



Low power view



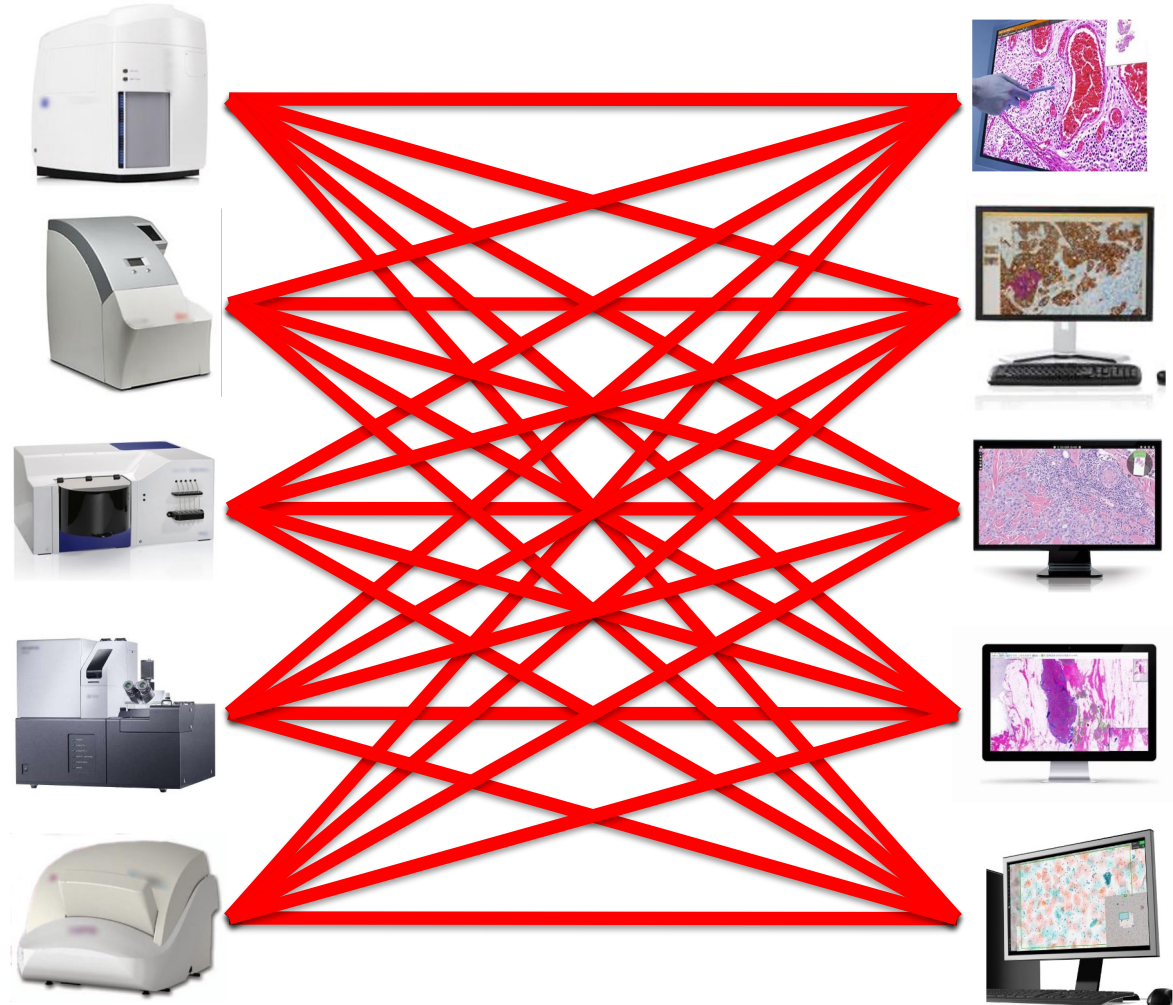
Low resolution



High power view

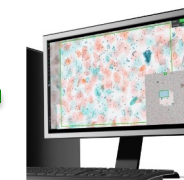
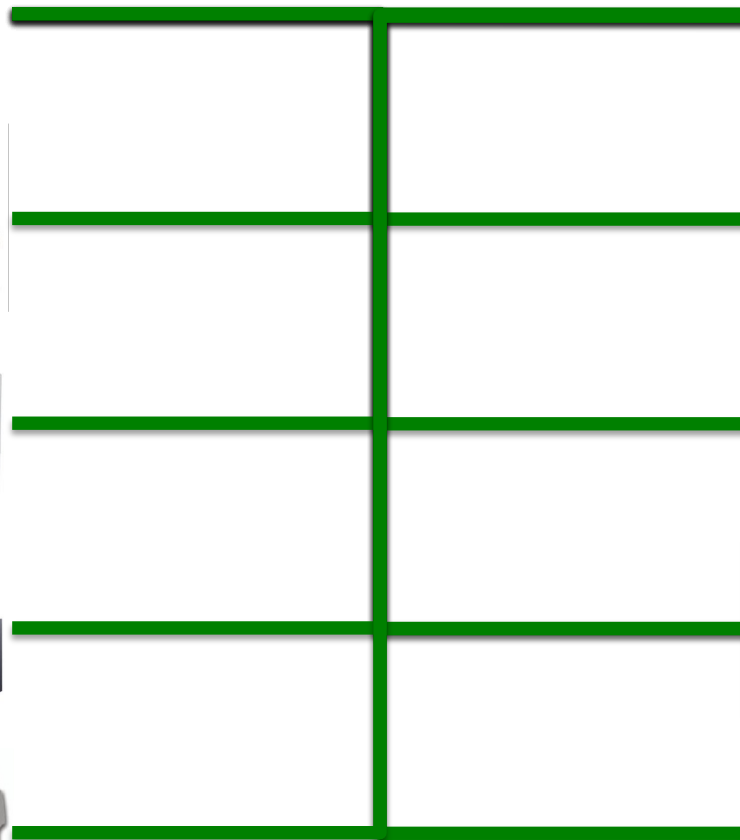
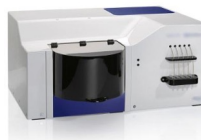
High resolution

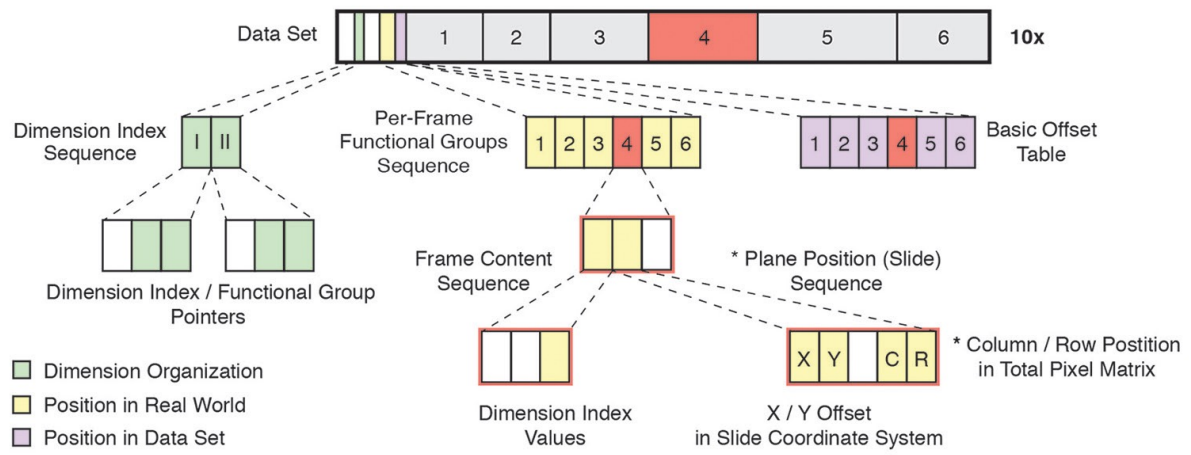
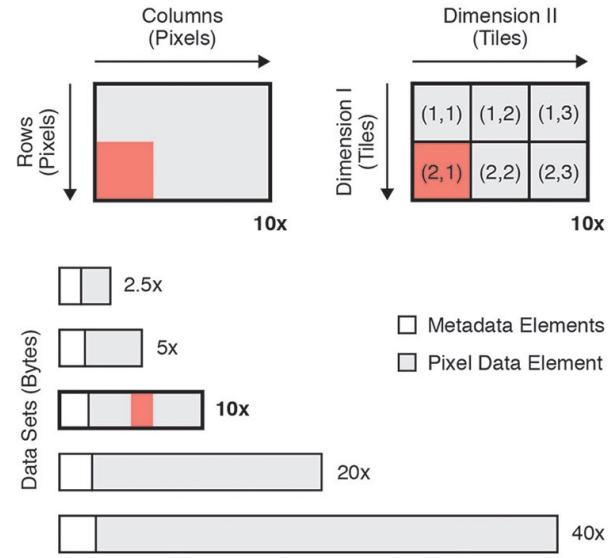
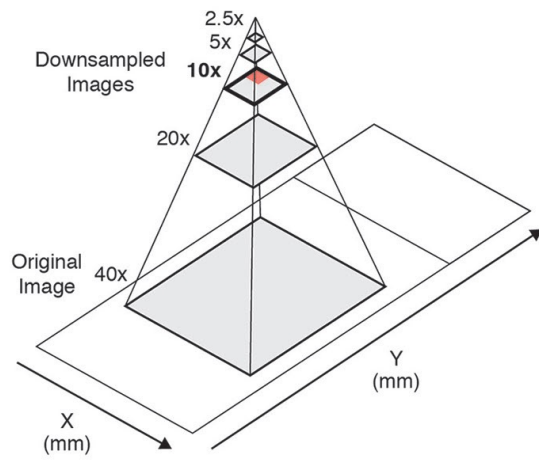
Whole slide imaging vendors have a long history of using proprietary file formats ☹️

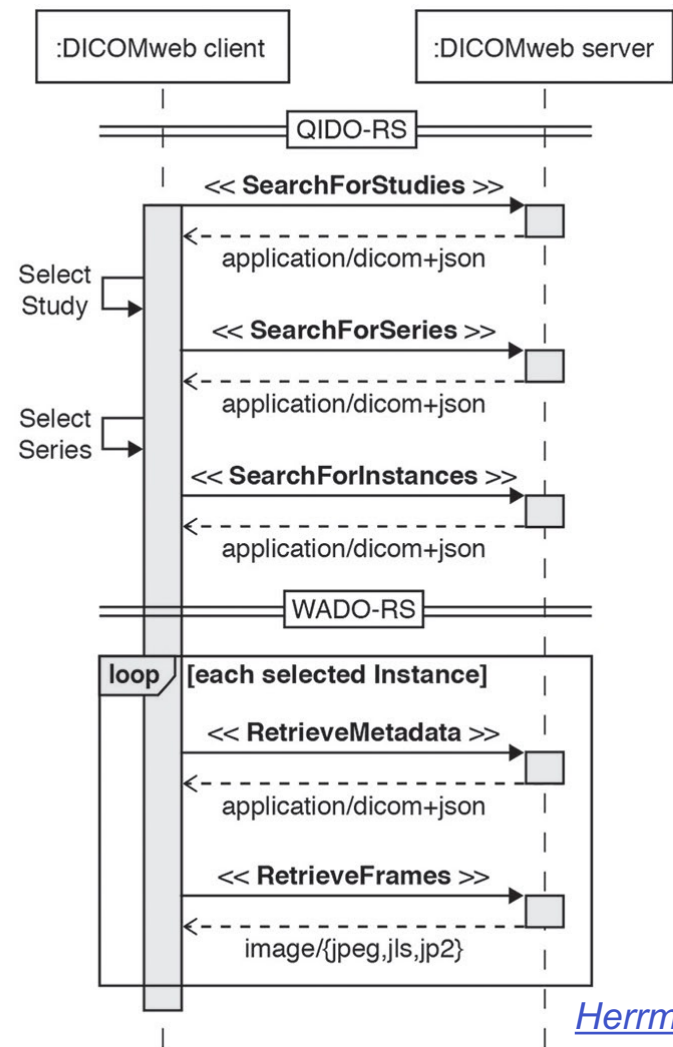
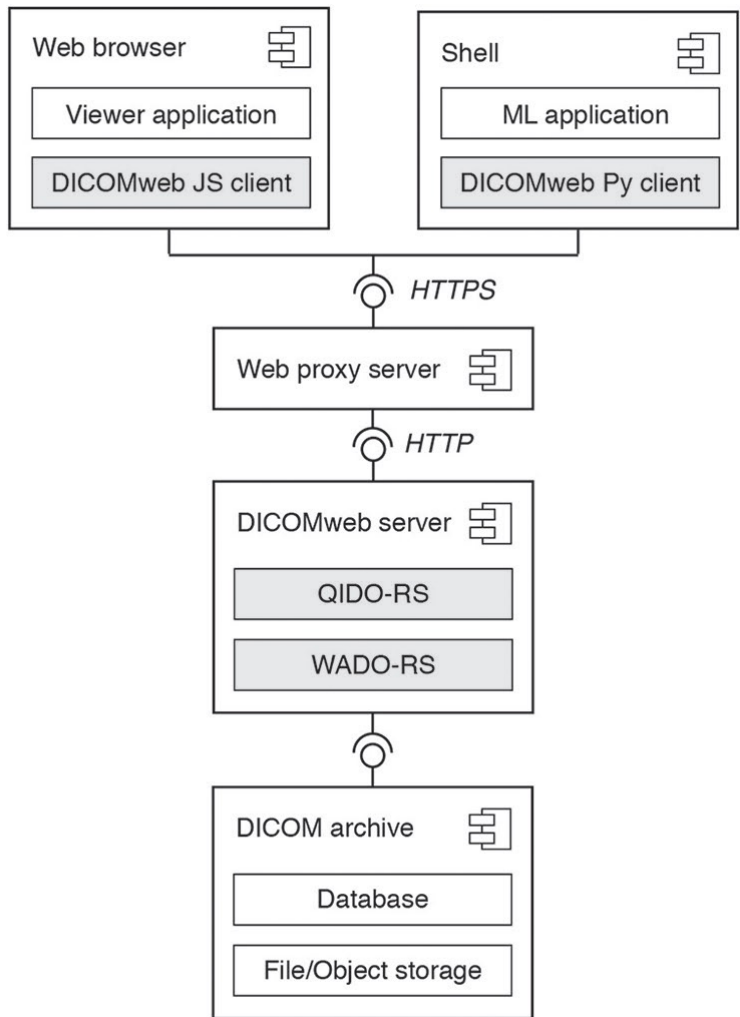




Digital Imaging and Communications in Medicine

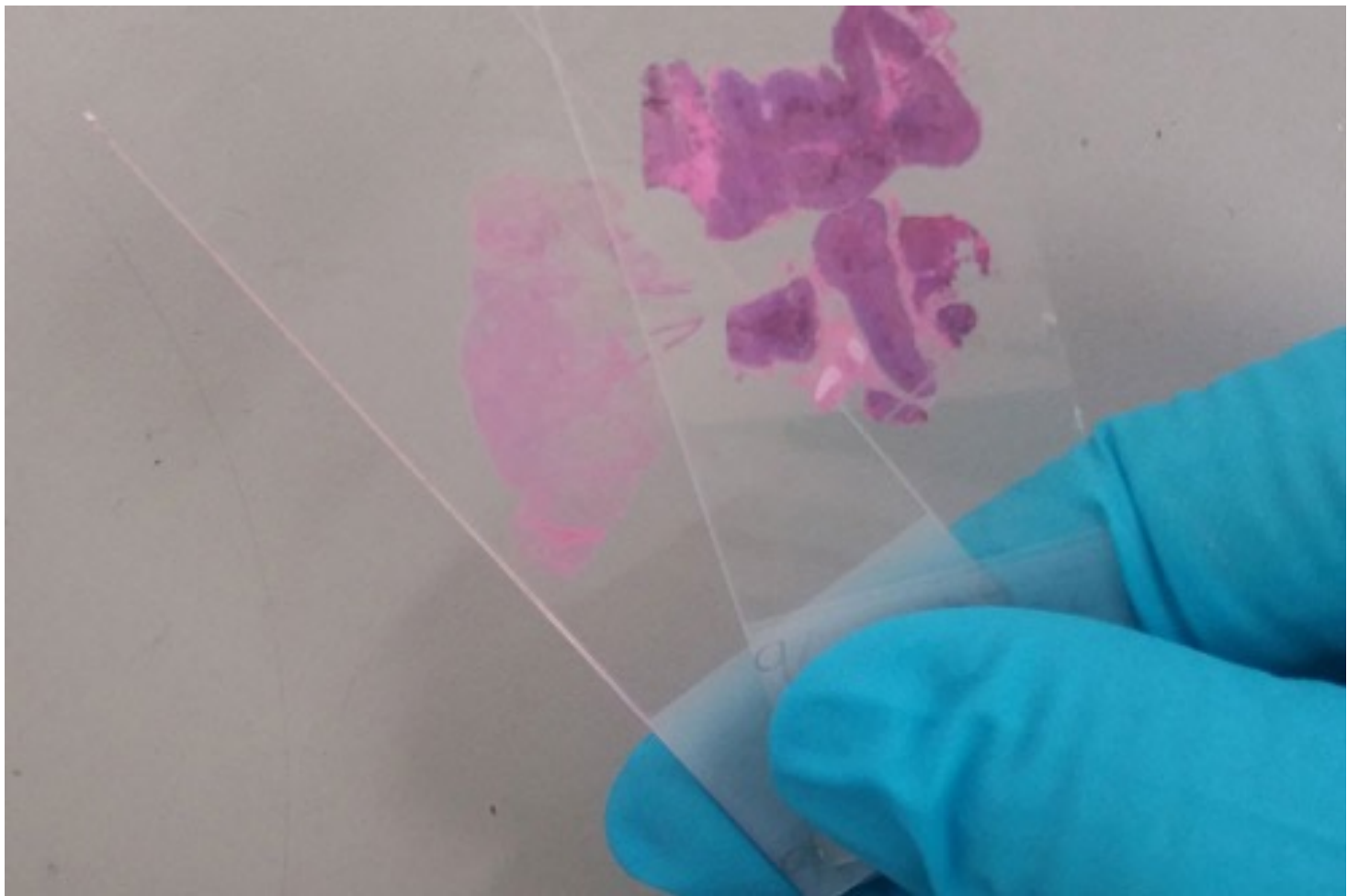




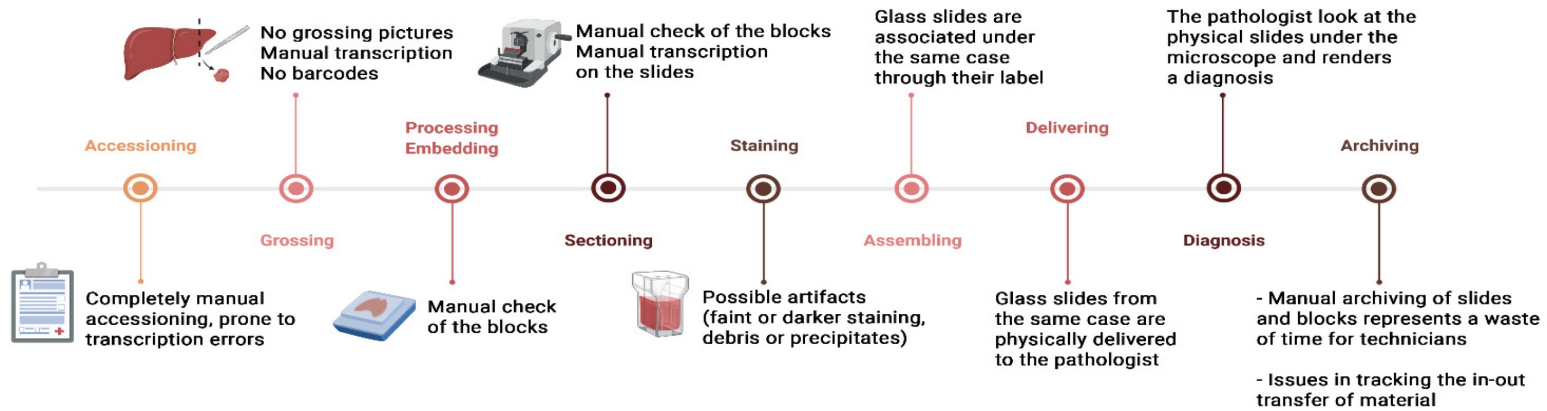




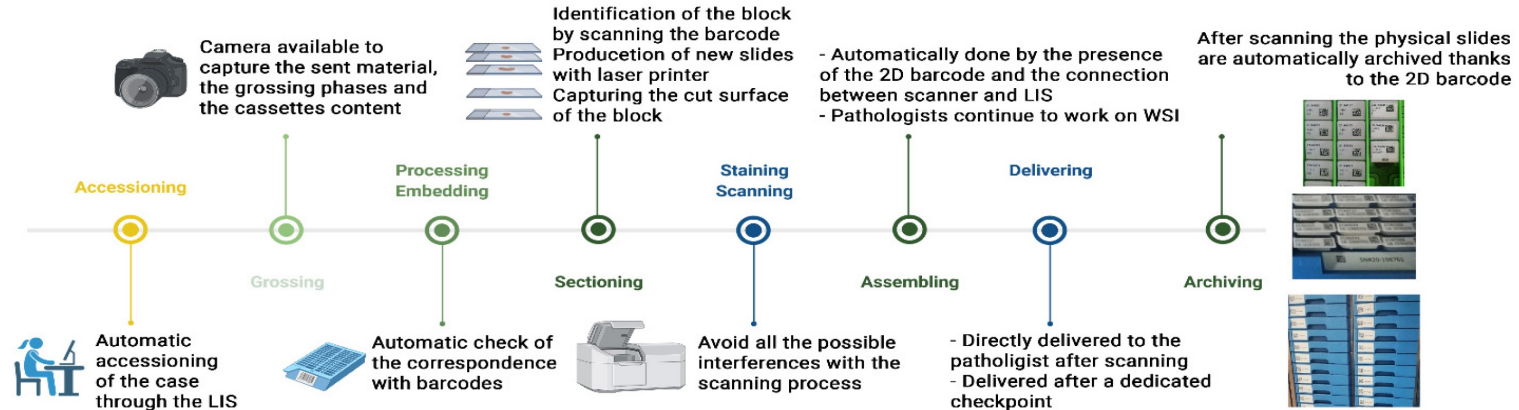
<http://www.fredhutch.org/en/research/shared-resources/core-facilities/experimental-histopathology.html>

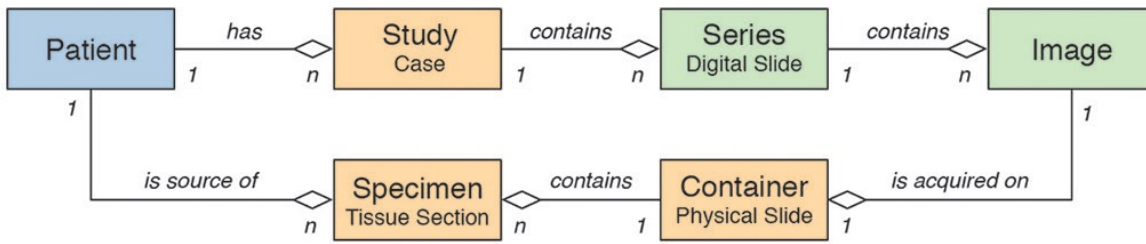


<http://www.bradford.ac.uk/media-v8/site/fols/ethical-tissue/Slides.jpg>



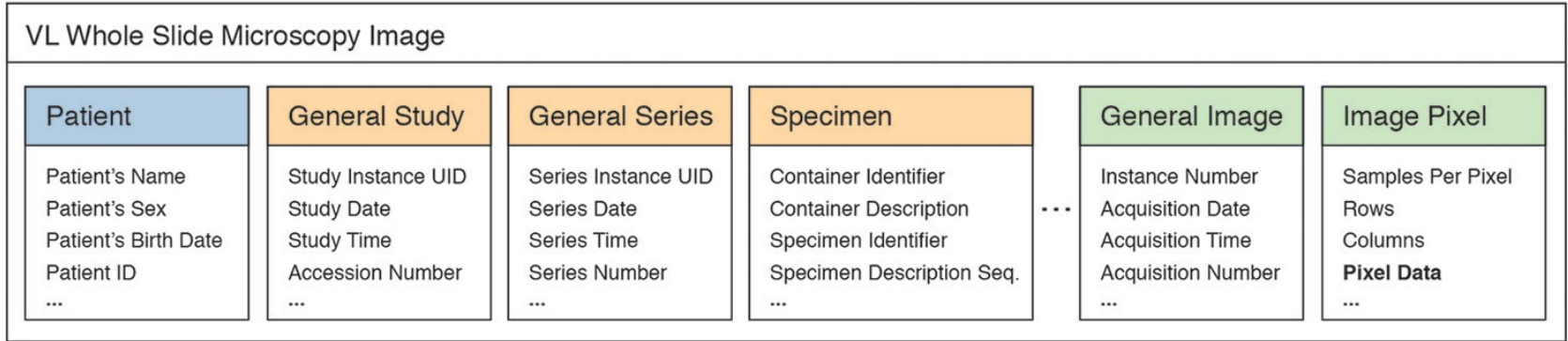
DIGITAL WORKFLOW Same steps, digital approach



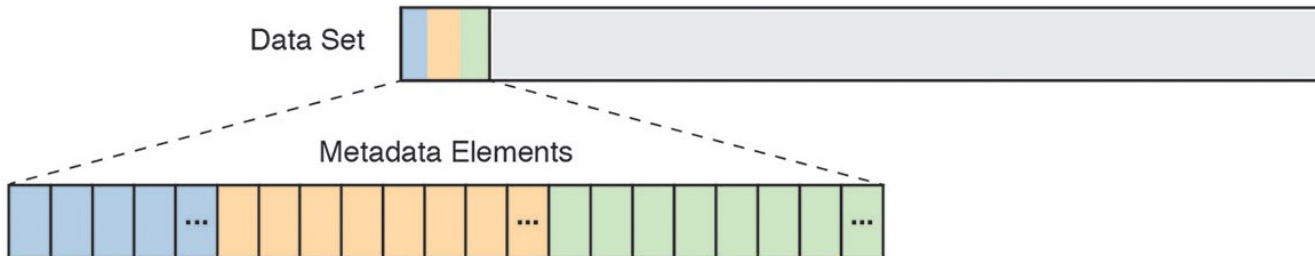


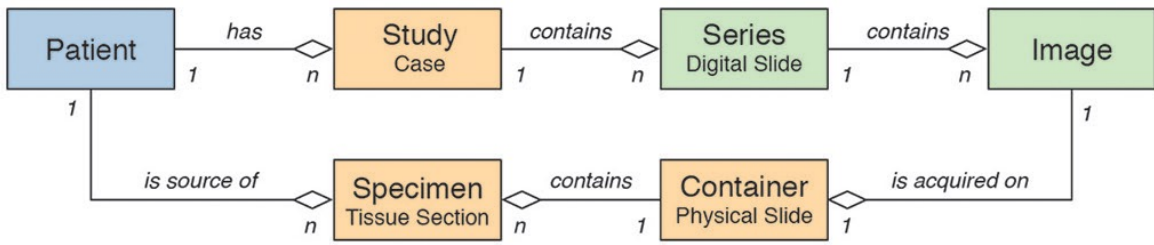
Information Source

- Microscope
- Laboratory Information System
- Electronic Medical Record



Pixel Data Element

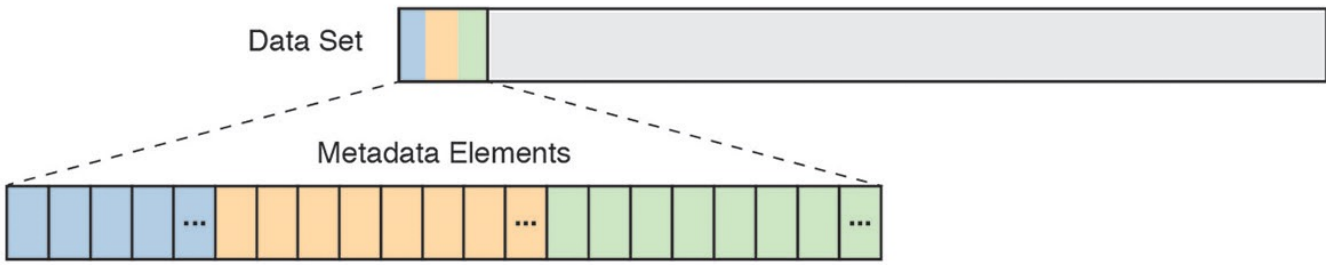




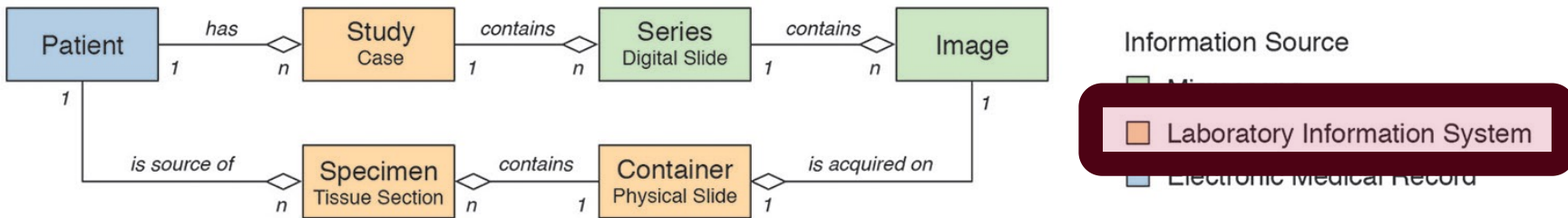
- Information Source
- Microscope
 - Laboratory Information System
 - Electronic Medical Record

VL Whole Slide Microscopy Image					
Patient	General Study	General Series	Specimen	General Image	Image Pixel
Patient's Name Patient's Sex Patient's Birth Date Patient ID ...	Study Instance UID Study Date <div style="border: 2px solid #800000; padding: 2px; display: inline-block;">Accession Number</div>	Series Instance UID Series Date Series Time Series Number ...	Container Identifier Container Description Specimen Identifier Specimen Description Seq. ...	Instance Number Acquisition Date Acquisition Time Acquisition Number ...	Samples Per Pixel Rows Columns Pixel Data ...

Pixel Data Element

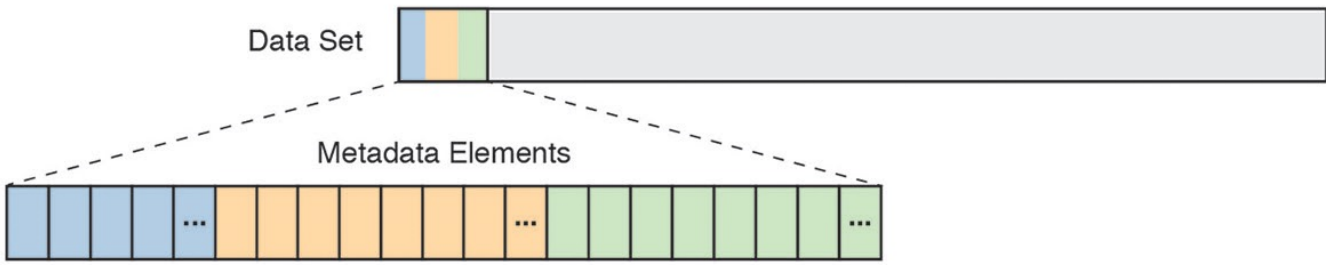


	2b	8001 / 2b	CODE	(371439000, SCT, "Specimen type")	(430861001, SCT, "Gross specimen")	
	3	8001 / 3	CODE	(111701, DCM, "Processing type")	(9265001, SCT, "Specimen Processing")	
	4	8001 / 4	DATETIME	(111702, DCM, "DateTime of processing")	200703231900	
	5	8001 / 5	TEXT	(111703, DCM, "Processing step description")	Standard Block Processing (Formalin)	
	6	8001 / 10	CODE	(430864009, SCT, "Tissue Fixative")	(111095003, SCT, "Formalin")	
5	1	8001 / 1	TEXT	(121041, DCM, "Specimen Identifier")	S07-100 A 5	Block embedding
	2	8001 / 2	TEXT	(111724, DCM, "Issuer of Specimen Identifier")	Case Medical Center	
	2a	8001 / 2a	CODE	(434711009, SCT, "Specimen container")	(434464009, SCT, "Tissue cassette")	
	2b	8001 / 2b	CODE	(371439000, SCT, "Specimen type")	(430861001, SCT, "Gross specimen")	
	3	8001 / 3	CODE	(111701, DCM, "Processing type")	(9265001, SCT, "Specimen Processing")	
	4	8001 / 4	DATETIME	(111702, DCM, "DateTime of processing")	200703240500	
	5	8001 / 5	TEXT	(111703, DCM, "Processing step description")	Embedding (paraffin)	
	6	8001 / 11	CODE	(430863003, SCT, "Embedding medium")	(255667006, SCT, "Paraffin")	
6	1	8001 / 1	TEXT	(121041, DCM, "Specimen Identifier")	S07-100 A 5 1	Slide Staining
	2	8001 / 3	CODE	(111701, DCM, "Processing type")	(127790008, SCT, "Staining")	
	3	8001 / 4	DATETIME	(111702, DCM, "DateTime of processing")	200703240700	
	4	8001 / 9 8003 / 1	CODE	(424361007, SCT, "Using substance")	(12710003, SCT, "hematoxylin stain")	
	5	8001 / 9 8003 / 1	CODE	(424361007, SCT, "Using substance")	(36879007, SCT, "water soluble eosin stain")	



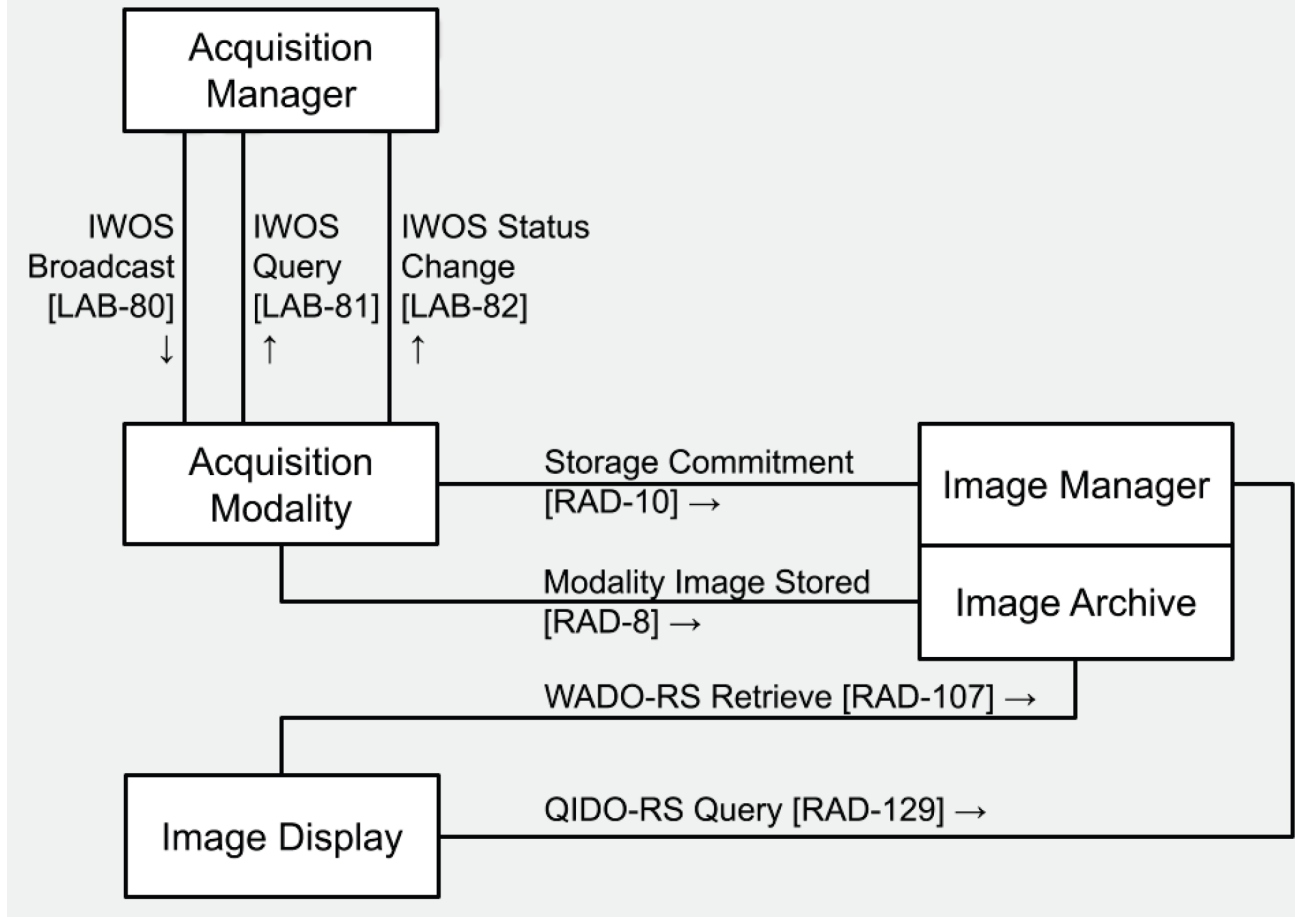
VL Whole Slide Microscopy Image					
Patient Patient's Name Patient's Sex Patient's Birth Date Patient ID ...	General Study Study Instance UID Study Date Accession Number	General Series Series Instance UID Series Date Series Time Series Number ...	Specimen Container Identifier Container Description Specimen Identifier Specimen Description Seq. ...	General Image Instance Number Acquisition Date Acquisition Time Acquisition Number ...	Image Pixel Samples Per Pixel Rows Columns Pixel Data ...

Pixel Data Element

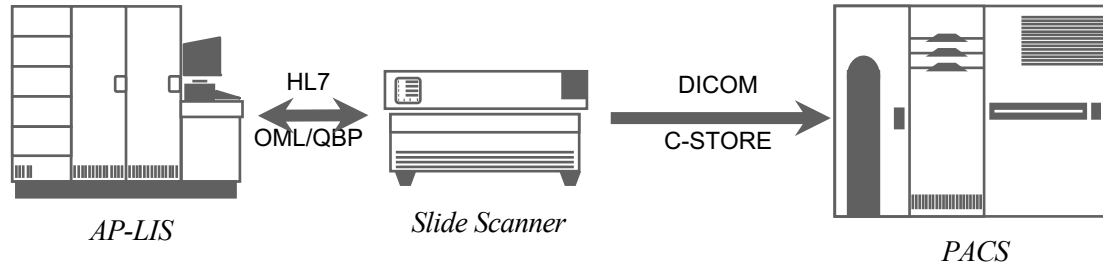




<http://idlabelinc.com/product/laboratory-labels/>

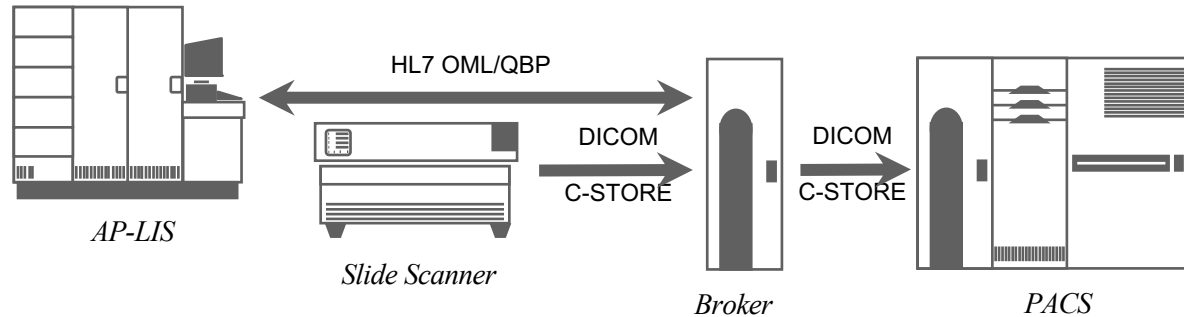


Who populates the DICOM meta-data from the AP-LIS?



HL7 AP-LIS Integration with Scanner (DPIA)

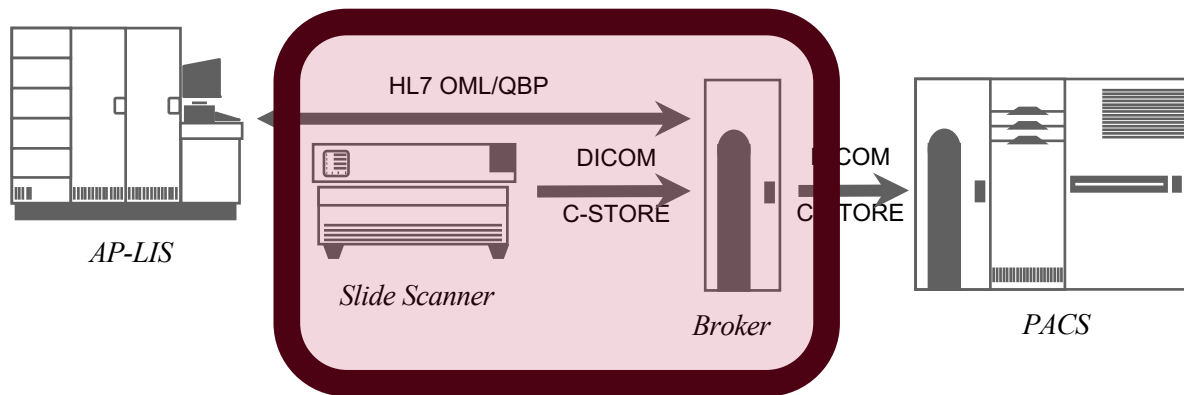
Who populates the DICOM meta-data from the AP-LIS?



Broker “improves” “naked” DICOM with IS Metadata

Who populates the DICOM meta-data from the AP-LIS?

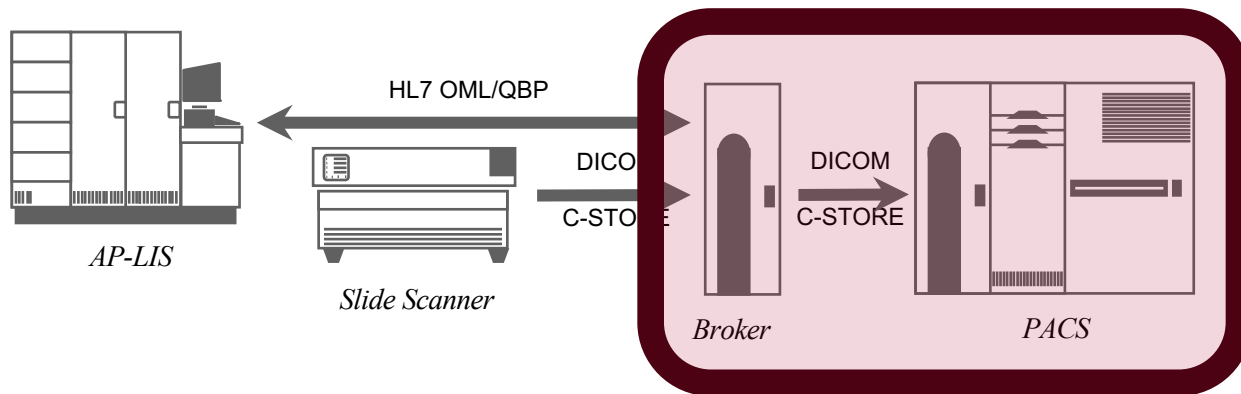
“Grouping” within single product transparent to customer



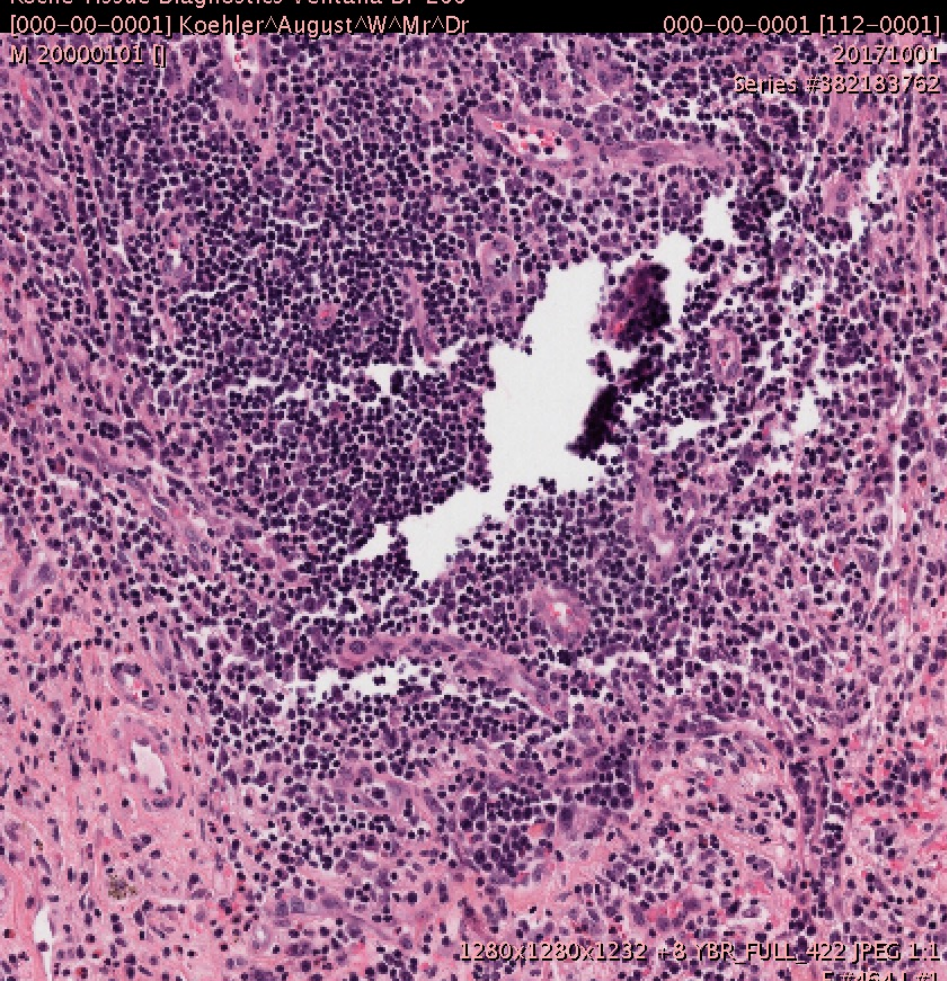
Broker “improves” “naked” DICOM with IS Metadata

Who populates the DICOM meta-data from the AP-LIS?

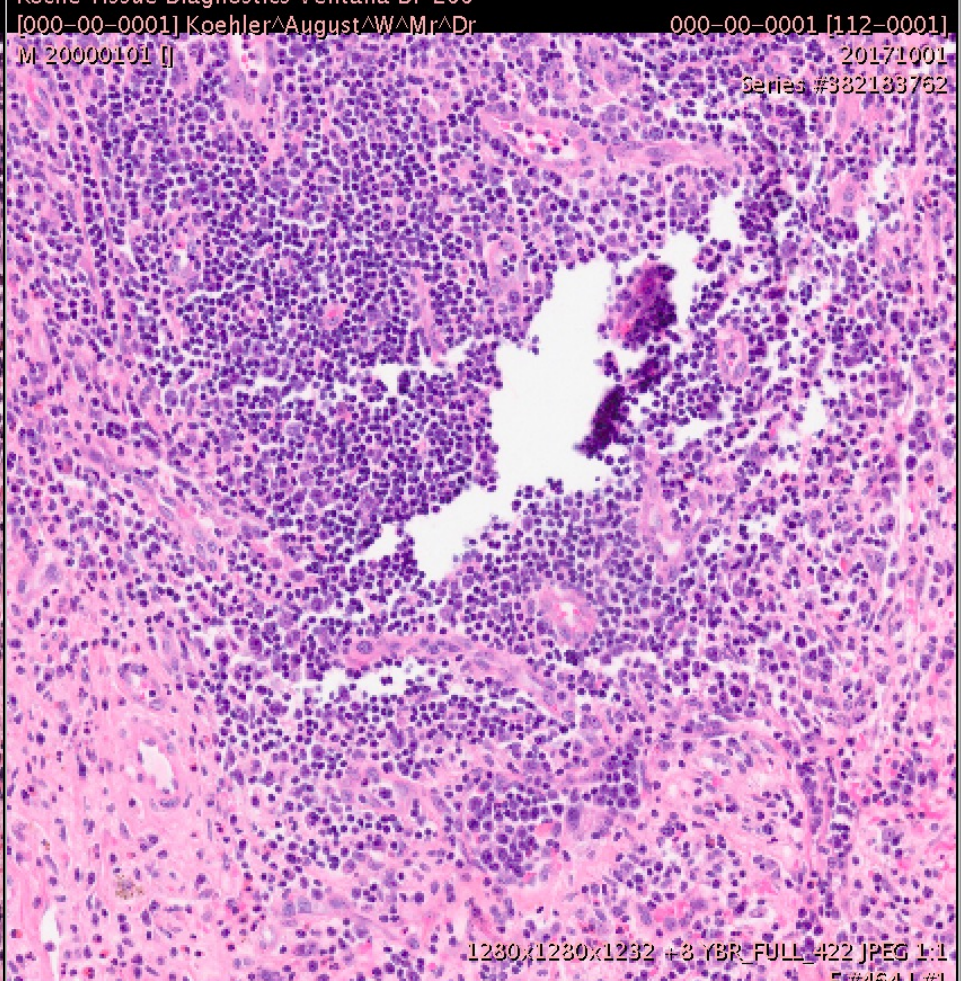
“Grouping” within single product transparent to customer



Broker “improves” “naked” DICOM with IS Metadata



No ICC Profile Applied



With ICC Profile Applied

Patient ^

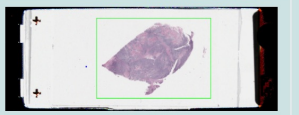
ID: RMS2152
Name: RMS2152
Gender: Male
Birthdate:

Study ^

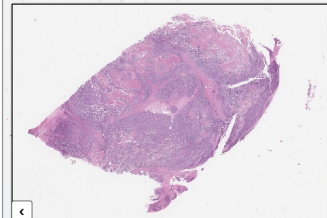
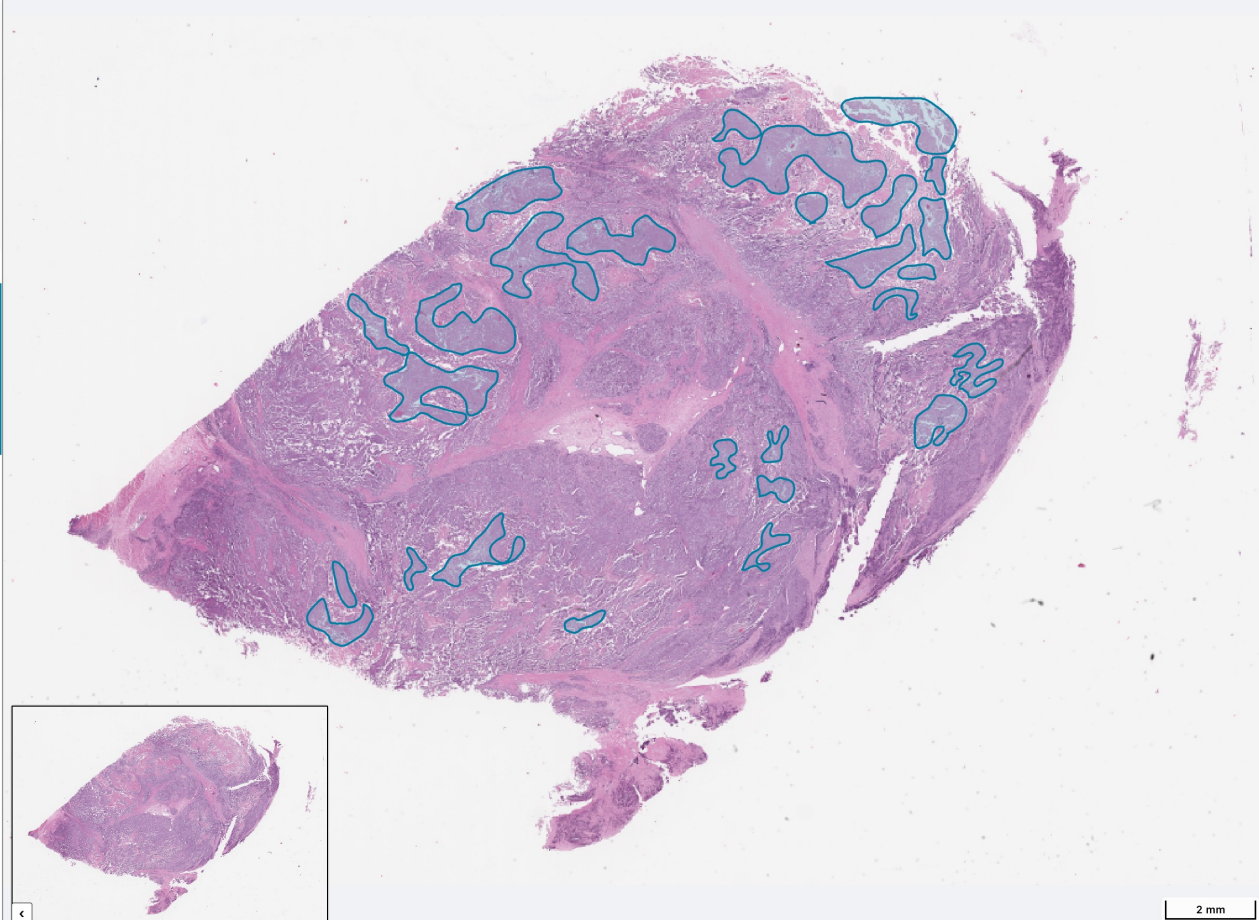
Accession #: RMS2152
ID: RMS2152
Date: 2018-10-31
Time: 16:31:25

Slides ^

PAPJAD-0BGUTB



(19.89090, 43.22370)

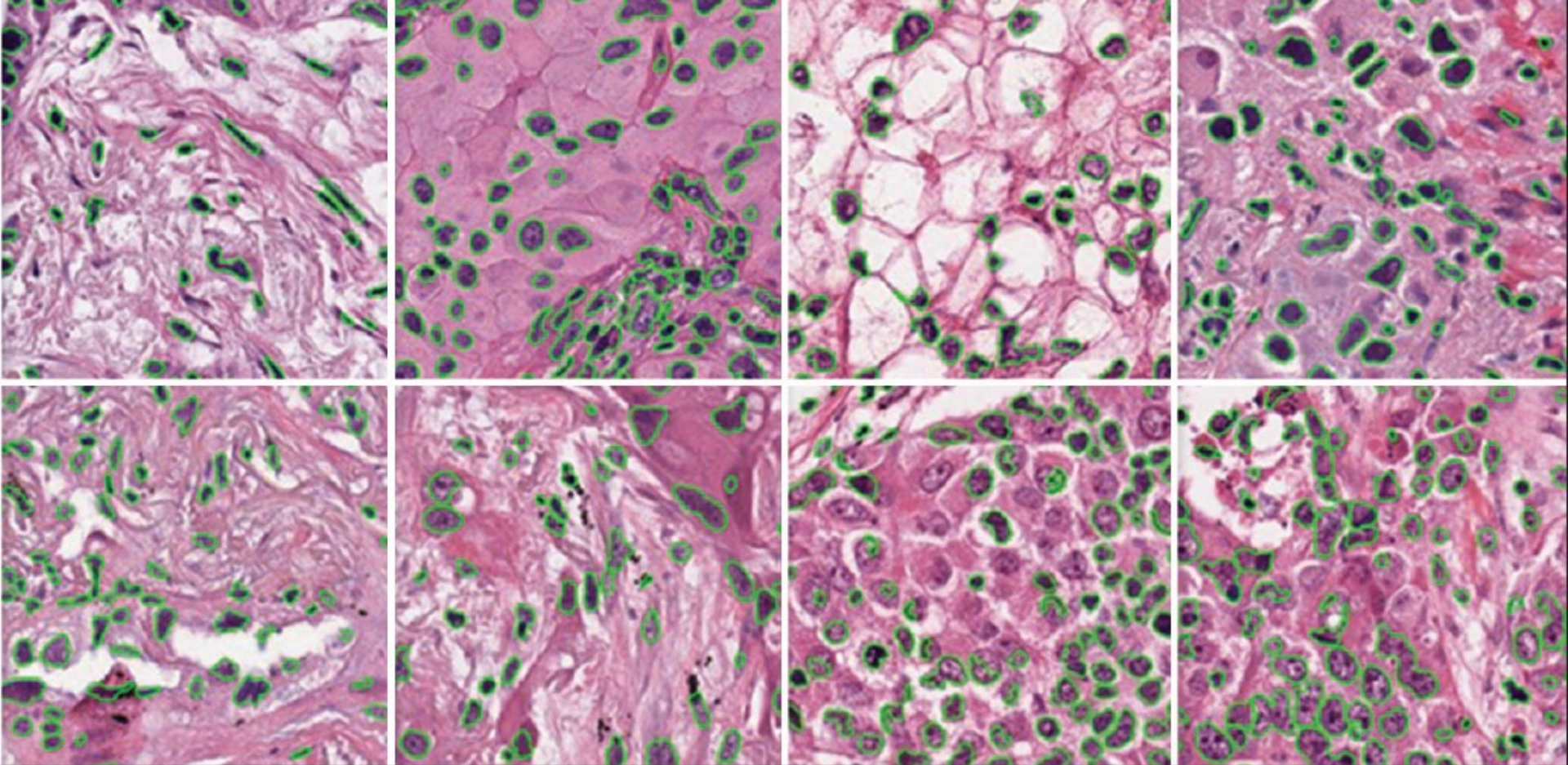


Optical Paths ^

- 1
- Tissue stain:
hematoxylin stain
- Tissue stain:
water soluble eosin stain

Annotations ^

- ROI 1
- Property category:
Morphologic abnormality
- Property type:
Alveolar rhabdomyosarcoma
- ROI 2
- Property category:
Body substance
- Property type:
Connective tissue
- ROI 3
- Property category:
Morphologic abnormality
- Property type:
Necrosis
- ROI 4
- Property category:
Morphologic abnormality
- Property type:
Necrosis
- ROI 5



Wen et al. A methodology for texture feature-based quality assessment in nucleus segmentation of histopathology image. JPI. 2017.