DICOM,
the Enterprise,
and Digital Pathology

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Pixelmed Publishing, LLC.

EHR

Enterprise Viewer
(view content standalone or in EHR)

ADT Messages

Imaging Procedure Order/Schedule Messages

Imaging Results Availability Messages

Store images imported via EHR utilities or patient portal into Enterprise Imaging Platform

Communications for viewing imaging exams data and metadata

Standards-based Communications (DICOM, HL7, Web Services, ...)

Enterprise Image Repository, Interface Engine
Modality Worklist Services

Standards-based Communications (DICOM, Web Services, ...)

Radiology
Cardiology
Orthopedics
Anesthesiology
Ophthalmology
Obstetrics and Gynecology
Dentistry
Urology
Surgery
Radiation Oncology
Others.....

Digital Capture Systems

Operating Rooms
Pathology
GI
Video Sources
Others.....

DICOM Wrap or XDS Import Software

Medical Camera Import
Video Clip Import
Mobile Photo App
Image Import API
Others.....

Gateways

CD Import/Export
Local HIE
Portals
Cloud Sharing App
Others.....

Group #1
Native DICOM Image Sources

Group # 2
Endoscopes, Microscopes, In-room Cameras

Group # 3
Photography, Video Clips, Mobile Apps, APIs

Group # 4
Image Exchange Inputs and Outputs

Roth et al. A Foundation for Enterprise Imaging. JDI. 2016.

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Correct Misperceptions

- Digital Pathology / WSI should:
  - be ***mainstream DICOM source*** like radiology (not some lame "digital capture" step-child)
  - have appropriate ***specialty-specific*** viewer accessible throughout the enterprise, not just the Anatomical Pathology department, just like radiology

DICOM – Enterprise Imaging

Standard Boundary

Standard Boundary

PACS +/- IS

Modality

Modality

Camera

Slide Scanner

Archive

Manager

Workstations

Analysis Systems
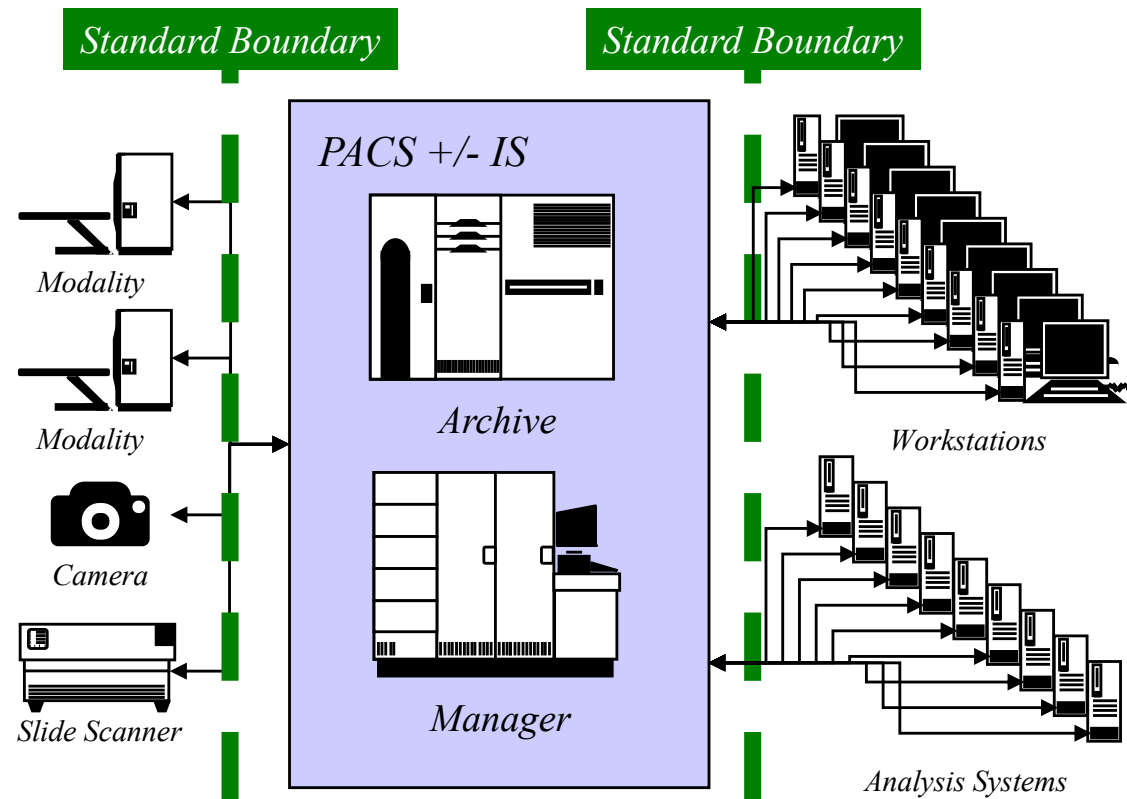
DICOM – Deconstructed PACS
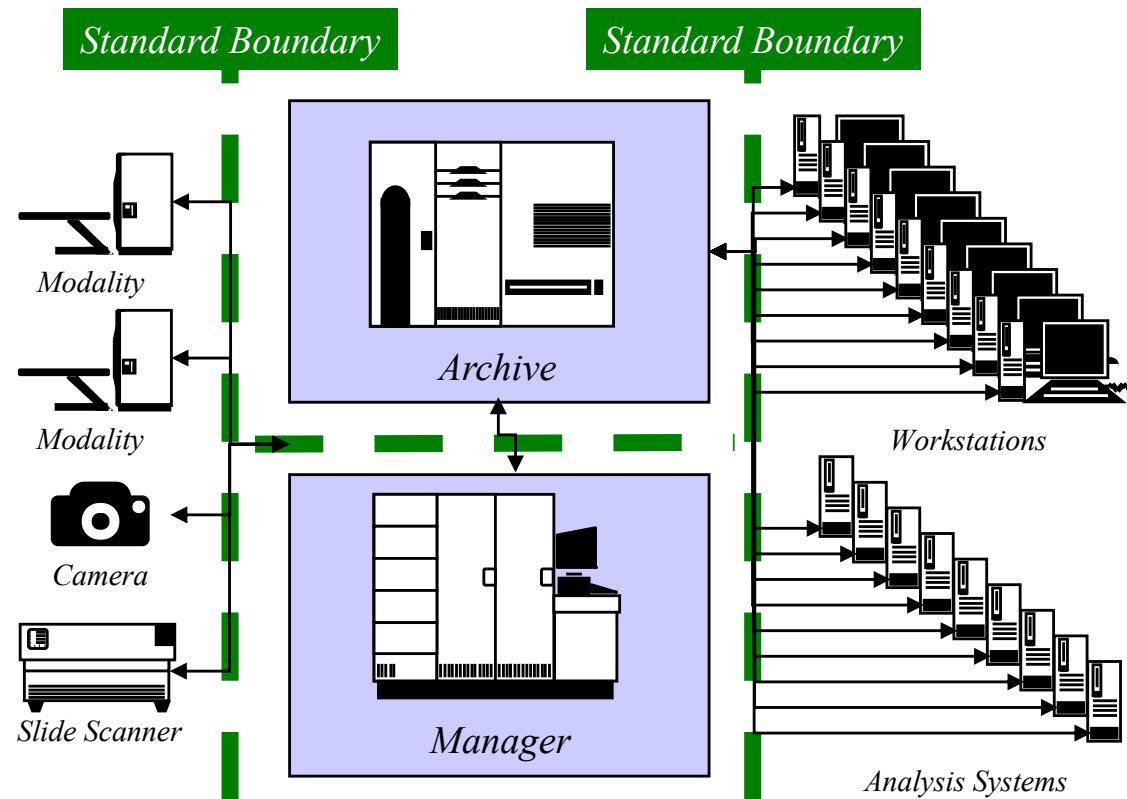
So what's the *big* deal with WSI?

- They're "big", really big
  - not that much bigger than a CT/PET or DBT
- DICOM pixel data encoding
  - just another multi-frame, color, compressed image
- Multi-frame rather than lots of single frame
  - as they get larger, run into timeouts during transfer
  - can't saturate transport connection with multiple simultaneous streams

An illustration of how digital slides are stored in a pyramid structure.

→ 1X Magnification

→ 10X Magnification

→ 40X Magnification
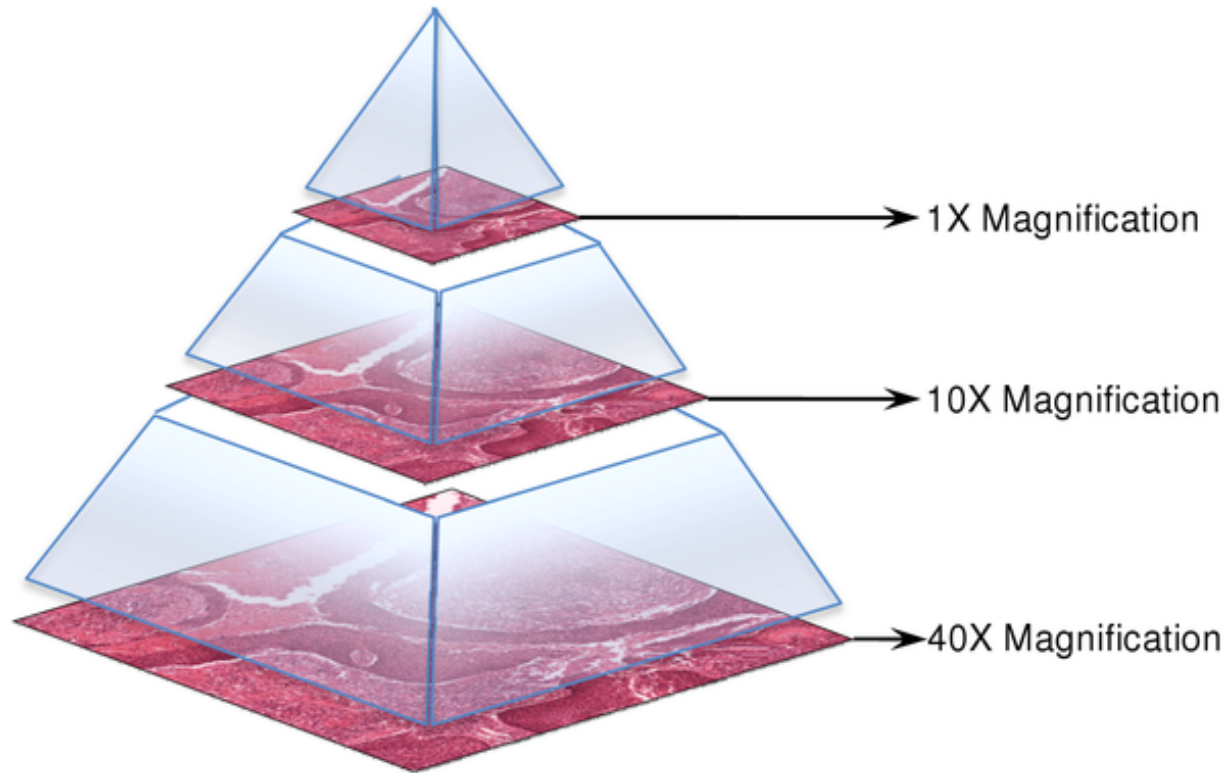
Wang Y, Williamson KE, Kelly PJ, James JA, Hamilton PW (2012) SurfaceSlide: A Multitouch Digital Pathology Platform. PLOS ONE 7(1): e30783. https://doi.org/10.1371/journal.pone.0030783
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0030783

Thumbnail Image
(low resolution)

Intermediate Zoom Image Tile

Intermediate Zoom Image
(intermediate resolution)

Retrieved image region

Baseline Image
(highest resolution)

Baseline Image Tile
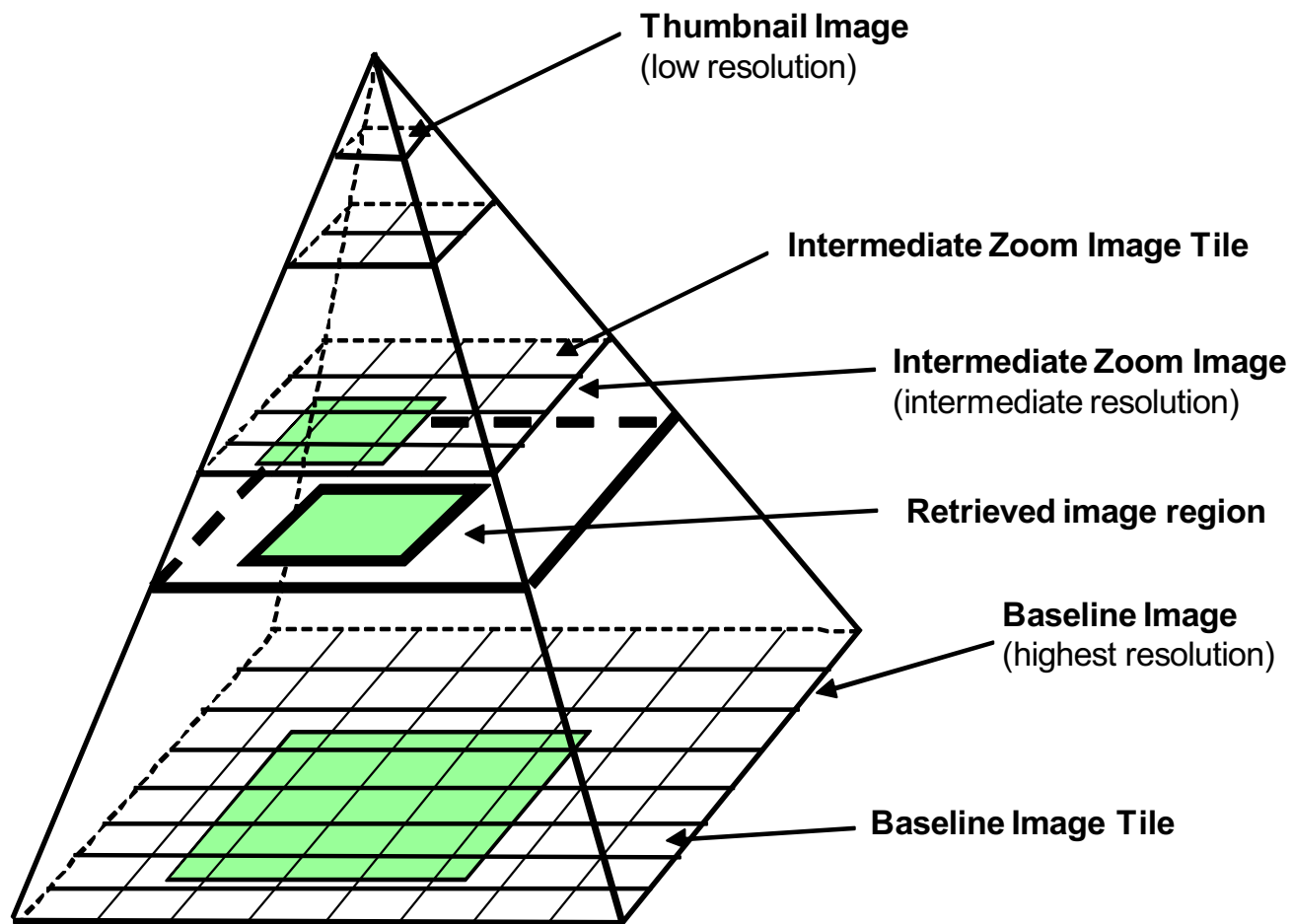
DICOM Supplement 145
Aperio, Digital Slides and Third-Party Data Interchange

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Multi-frame v. Single Frame

Shared attributes

Per-frame attributes

Pixel data

Concatenations

Shared attributes

Per-frame attributes

Pixel data
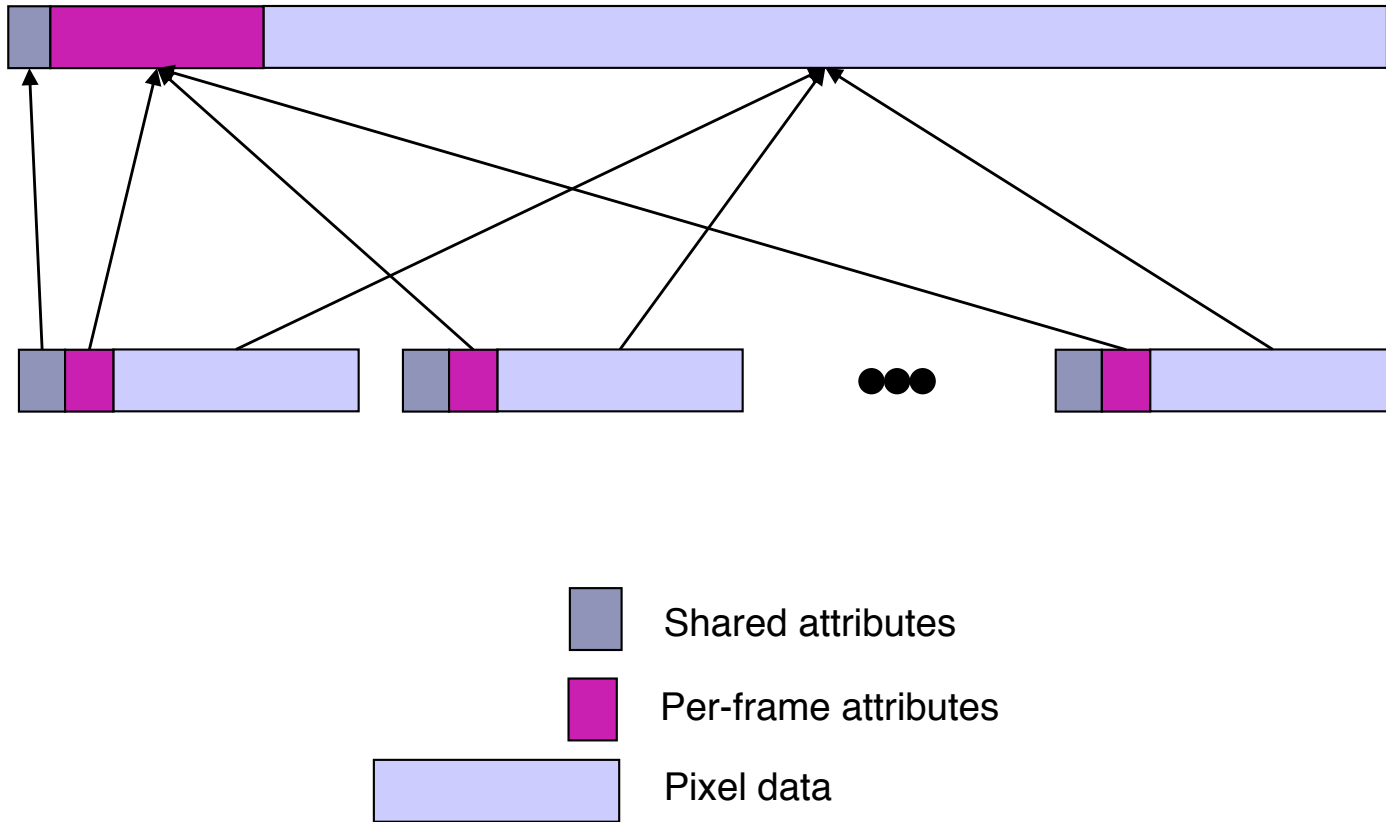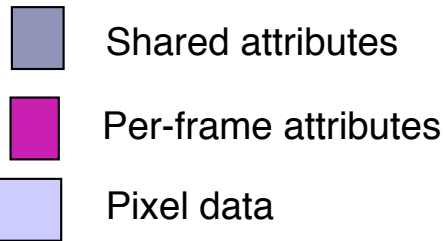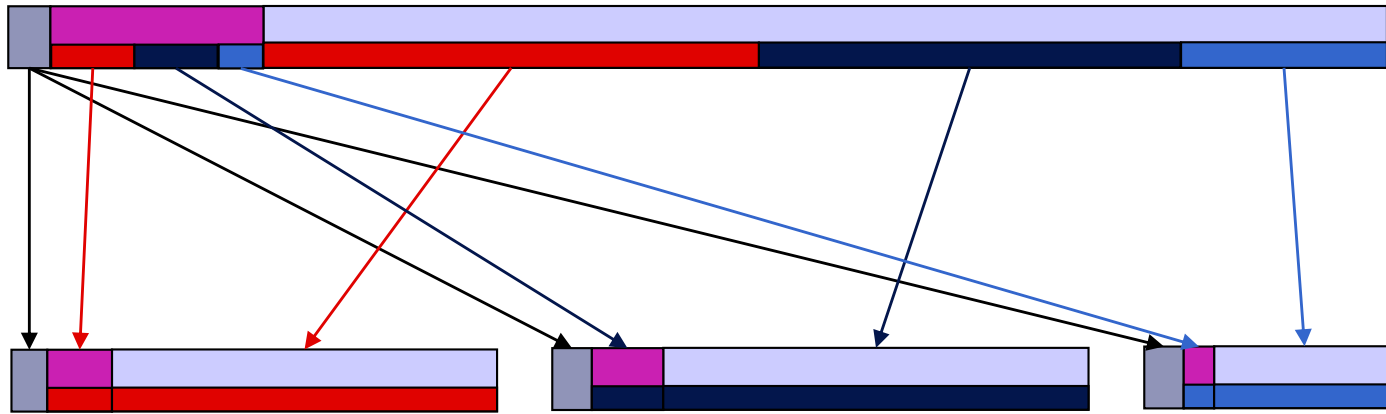
Store & Regurgitate Only?

Scanner Stores DICOM WSI

DICOM

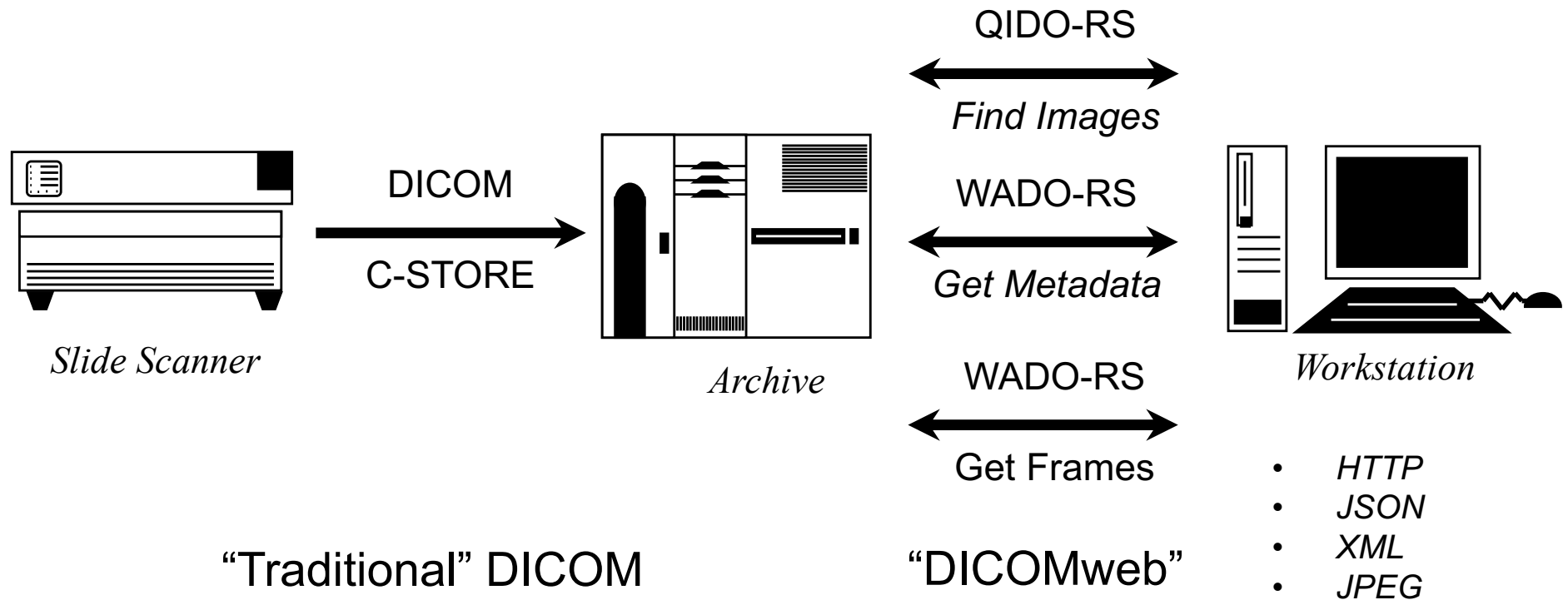C-STORE
or STOW-RS
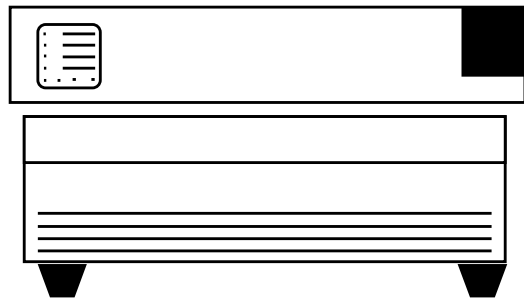
Slide Scanner
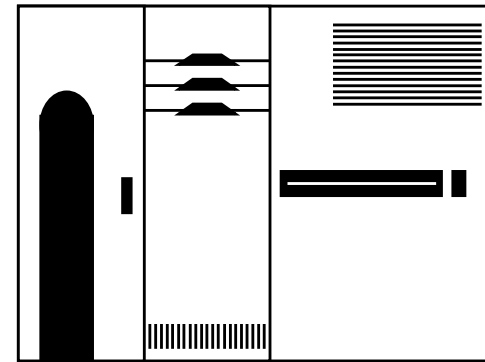
Archive

DICOM WSI to Black Box PACS

Standard Boundary

Slide Scanner

Slide Scanner

Slide Scanner

Slide Scanner
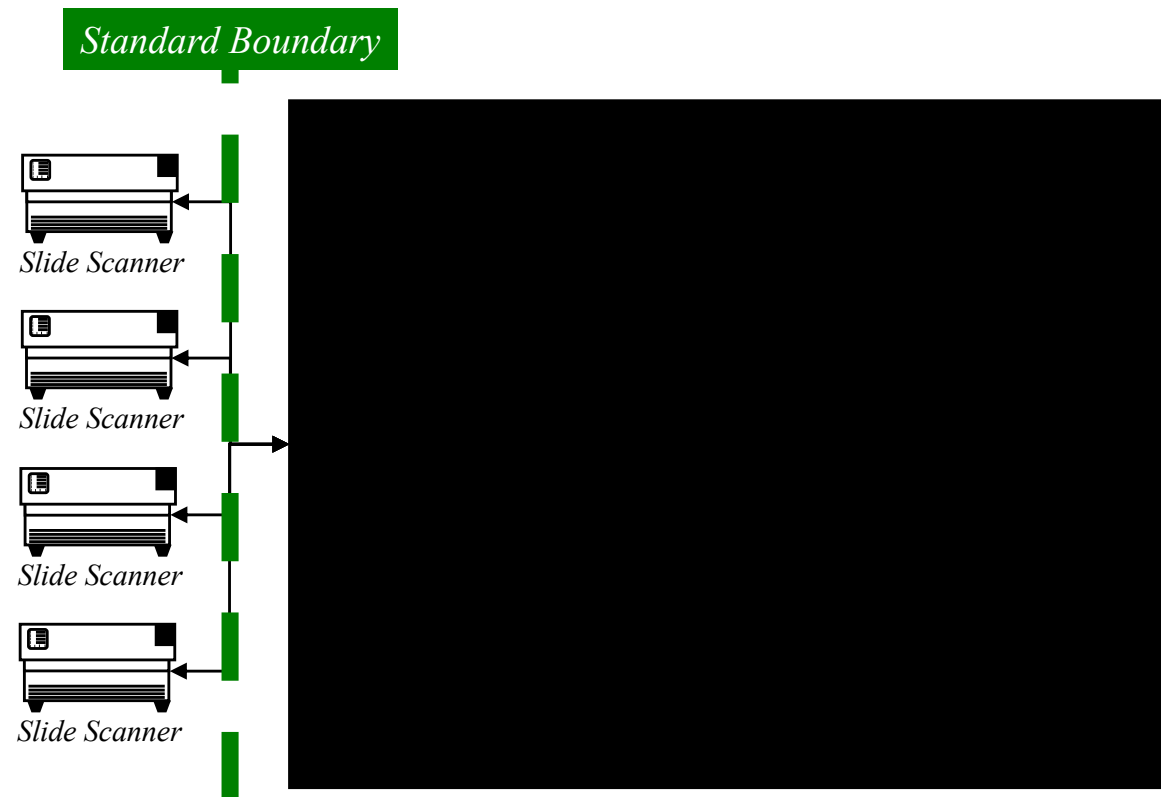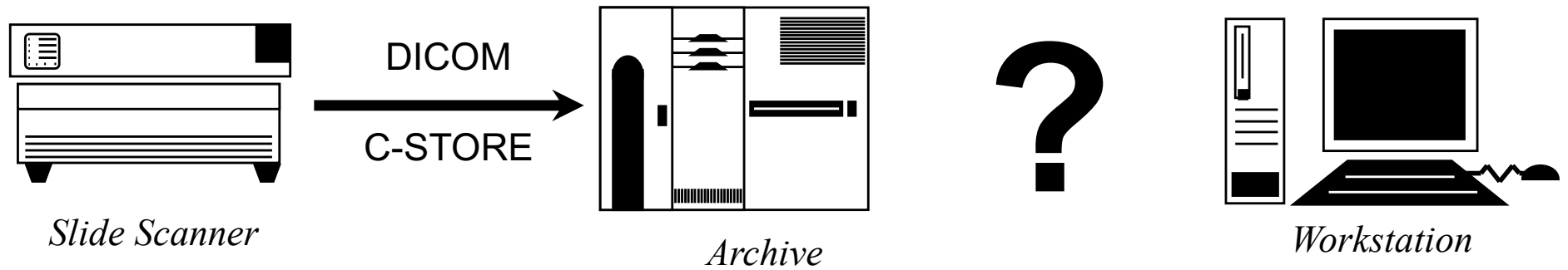
Virtual Microscopy Viewer Queries/Retrieves DICOM WSI

Virtual Microscopy Viewer Queries/Retrieves DICOM WSI

QIDO-RS

Find Images

WADO-RS

Get Metadata

WADO-RS

Get Frames

DICOM

C-STORE

Slide Scanner

Archive

Workstation

Virtual Microscopy Viewer Queries/Retrieves DICOM WSI

QIDO-RS
Find Images

WADO-RS
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WADO-RS
Get Frames

DICOM
C-STORE

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Workstation

"Traditional" DICOM

"DICOMweb"

- *HTTP*
- *JSON*
- *XML*
- *JPEG*

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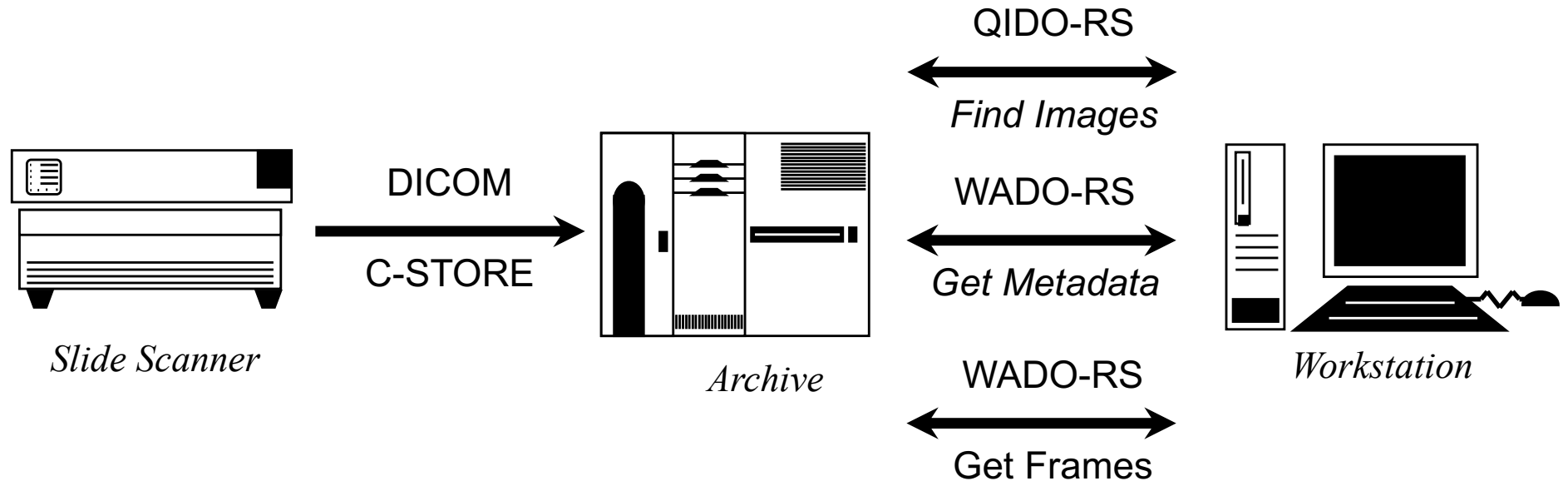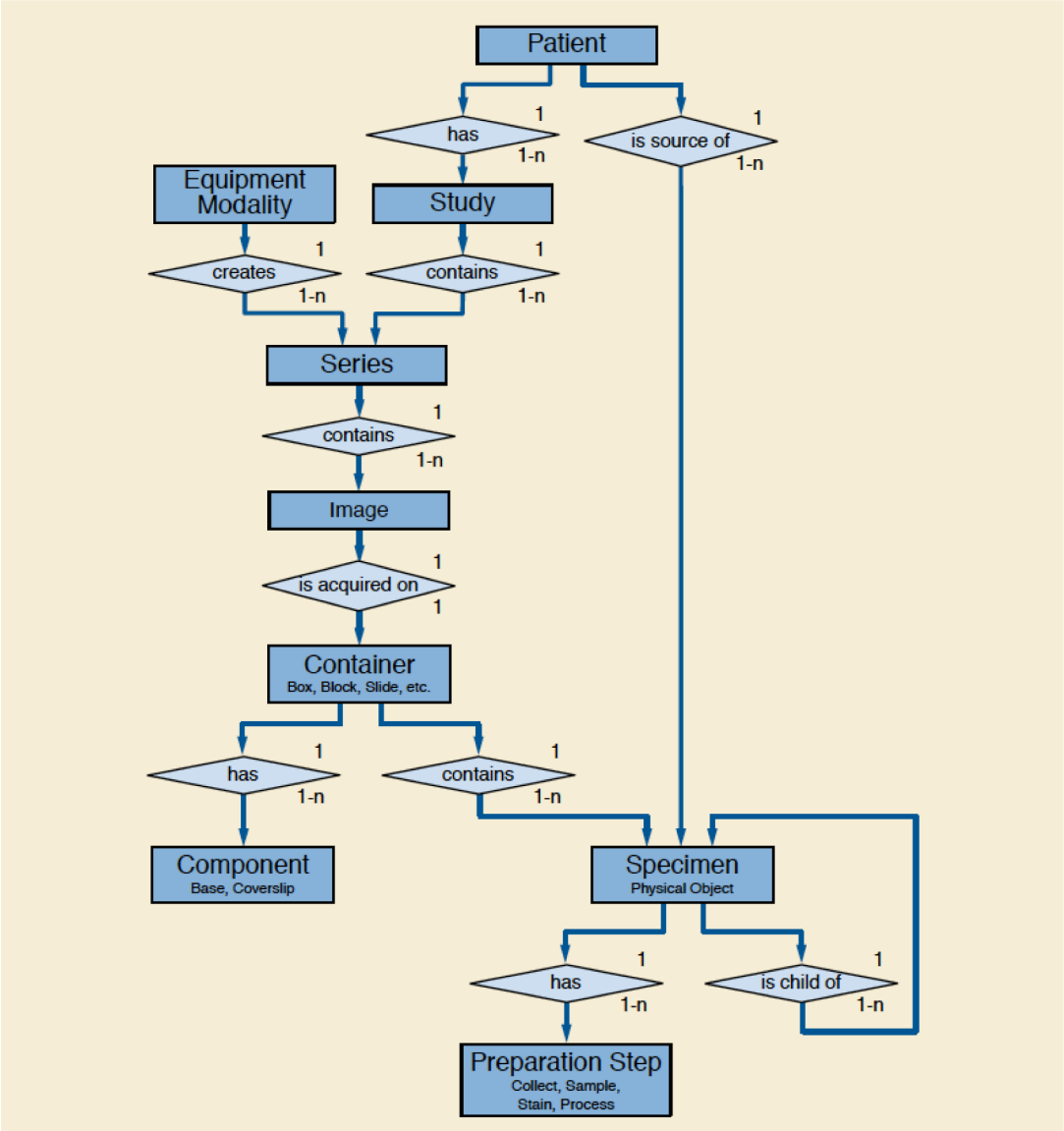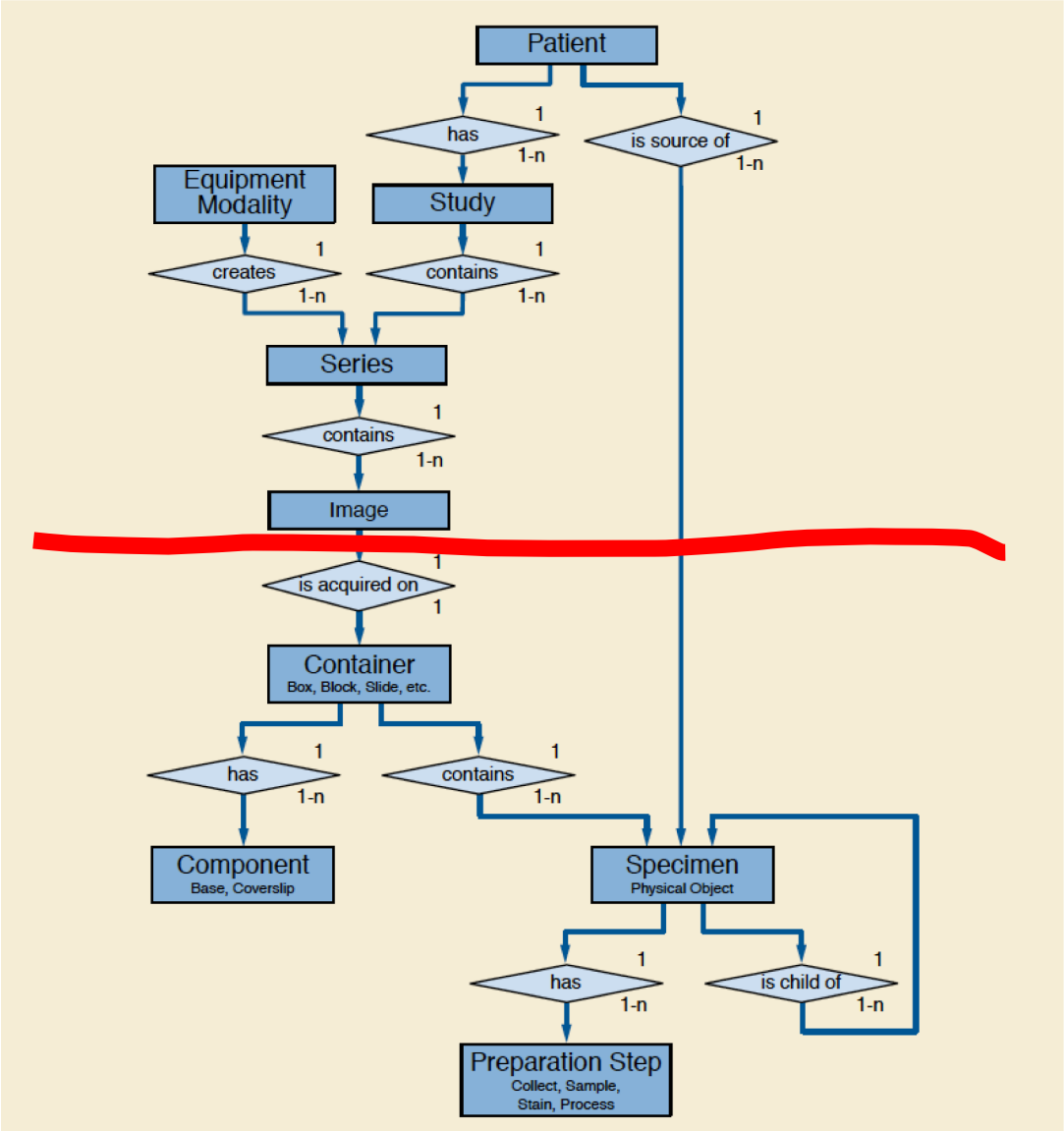
DICOM Archive Requirements

- Support WSI Storage SOP Class
- Support JPEG baseline and J2K Transfer Syntaxes
- Be careful at 2GB and 4GB boundaries (e.g., frame byte offset)
- Pay attention to timeouts
- Accept and reassemble concatenations
- Support DICOMweb QIDO-RS and WADO-RS for viewer query, metadata and frame level retrieval
- Index pathology-specific metadata for queries

Summary

- Not all "VNAs" are created equal
- There is no such thing as a "universal viewer" unless it incorporates the union of all specialty-specific navigation and visualization paradigms and features
- WSI is just another flavor of DICOM – but the devil is in the details
- There is more to WSI than just creating a DICOM file, the viewer interface and workflow are paramount