Selection and Implementation of a Digital Pathology System

Toby C. Cornish, MD, PhD
Associate Professor of Pathology
University of Colorado
School of Medicine

May 23rd, 2016

Notice of Faculty Disclosure

In accordance with ACCME guidelines, any individual in a position to influence and/or control the content of this ASCP CME activity has disclosed all relevant financial relationships within the past 12 months with commercial interests that provide products and/or services related to the content of this CME activity.

The individual below has responded that he/she has no relevant financial relationship(s) with commercial interest(s) to disclose:

Toby Cornish, MD, PhD

Objectives

- At the conclusion of this activity, the learner should:
  - Understand the basic principles of whole slide imaging
  - Recognize key differences in WSI scanners
  - Be able to develop an approach to WSI device/system selection
  - Understand the steps in implementing a WSI system
  - Understand post-implementation requirements

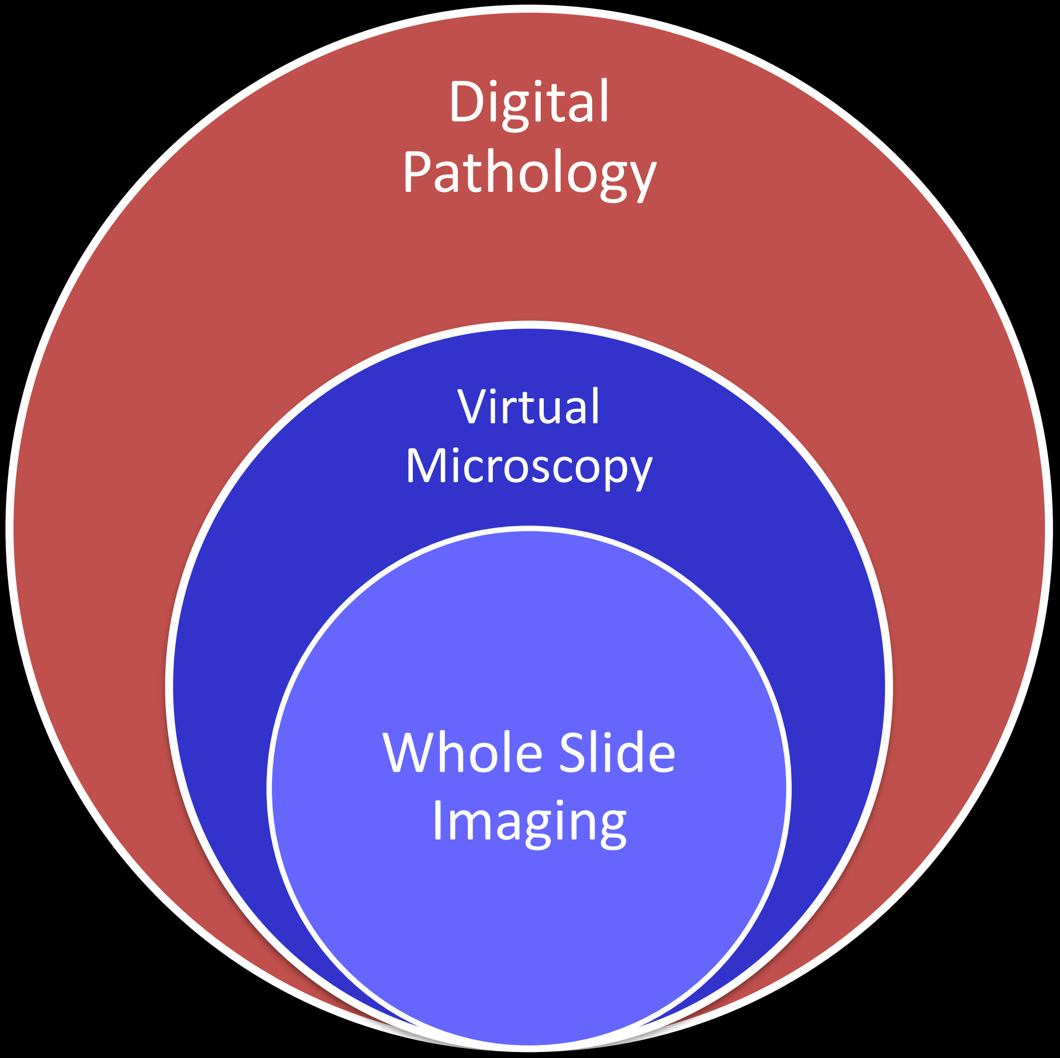
Introduction
Planning an evaluation
Comparing WSI systems
Purchasing a system
Implementation
Post-implementation

Introduction

What is digital pathology?

- Digital Pathology Association (DPA):
  - DIGITAL PATHOLOGY: A dynamic, image-based environment that enables the acquisition, management and interpretation of pathology information generated from a digitized glass slide. Often used interchangeably with "Virtual Microscopy."

https://digitalpathologyassociation.org/glossary-of-terms_1


Digital Pathology
Virtual Microscopy
Whole Slide Imaging

What is a whole slide image (WSI)?

- A single, high magnification digital image of an entire microscopic slide

In a nutshell, how does WSI work?

- An automated microscope “knits” smaller images together into a single large image
- This WSI is stored usually in a digital slide repository
- View the WSI locally or remotely = virtual microscopy

“First” slide scanner

- Robotic/automated microscopes with specialized acquisition software
- James Bacus, PhD
- BLISS System (c. 1994)
- First dedicated “virtual microscopy” system
- First patent filed March 1997

Bacus Patents (partial list)

- Bacus, J.V., **Bacus J.W.**: Method and Apparatus for Acquiring and Reconstructing Magnified Specimen Images from a Computer-Controlled Microscope. U.S. Patent 6,101,265. 2000.
- Bacus, J.V., **Bacus J.W.**: Method and Apparatus for Creating a Virtual Microscope Slide. U.S. Patent 6,272,235. 2001.
- Bacus, J.V., **Bacus J.W.**: Method and Apparatus for Acquiring and Reconstructing Magnified Specimen Images from a Computer-Controlled Microscope. U.S. Patent 6,226,392. 2001.
- **Bacus, J.W.**, Bacus J.V.: Method and Apparatus for Internet, Intranet, and Local Viewing of Virtual Microscope Slides. U.S. Patent 6,396,941. 2002.
- Bacus, J.V., **Bacus J.W.**: Method and Apparatus for Acquiring and Reconstructing Magnified Specimen Images from a Computer-Controlled Microscope. U.S. Patent 6,404,906. 2002.
- Bacus, J.V., **Bacus J.W.**: Method and Apparatus for Processing an Image of a Tissue Sample Microarray. U.S. Patent 6,466,690, 2000.
- **Bacus, J.W.**, Bacus J.V.: Method and Apparatus for Creating a Virtual Microscope Slide. U.S. Patent 6,522,774 2003.
- **Bacus, J.W.**, Bacus J.V.: Method and Apparatus for Internet, Intranet, and Local Viewing of Virtual Microscope Slides. U.S. Patent 6,674,881. 2004.
- Bacus, J.V., **Bacus J.W.**: Apparatus for Remote Control of a Microscope.U.S. Patent 6,674,884. 2004.
- **Bacus, J.W.**, Bacus J.V.: Method and Apparatus for Creating a Virtual Microscope Slide. U.S. Patent U.S. Patent 6,775,402. 2004.
- Bacus, J.V., **Bacus J.W.**: Apparatus for Remote Control of a Microscope.U.S. Patent 7,110,586. 2006.
- **Bacus, J.W.**, Bacus J.V.: Method and Apparatus for Creating a Virtual Microscope Slide. U.S. Patent 7,146,372. 2006.
- **Bacus, J.W.**, Bacus J.V.: Method and Apparatus for Internet, Intranet, and Local Viewing of Virtual Microscope Slides. U.S. Patent 7,149,332. 2006.

http://www.jamesbacus.com/page3.html

The Virtual Microscope

- Ferreira R, Moon B, Humphries J, Sussman A, Saltz J, Miller R & Demarzo A (1997).
- *Proceedings of the 1997 AMIA Annual Fall Symposium*, 449-453.

The Virtual Microscope *

Renato Ferreira[†], Bongki Moon, Ph.D.[†], Jim Humphries[†], Alan Sussman, Ph.D.[†],
Joel Saltz, M.D., Ph.D.[† ‡], Robert Miller, M.D.[‡], Angelo Demarzo, M.D.[‡]

[†]UMIACS and Dept. of Computer Science
University of Maryland
College Park, MD 20742

[‡]Department of Pathology
Johns Hopkins Medical Institutions
Baltimore, MD 21287

{renato,bkmoon,humphrie,als,saltz}@cs.umd.edu
{rmiller,ademarz}@pds.path.jhu.edu

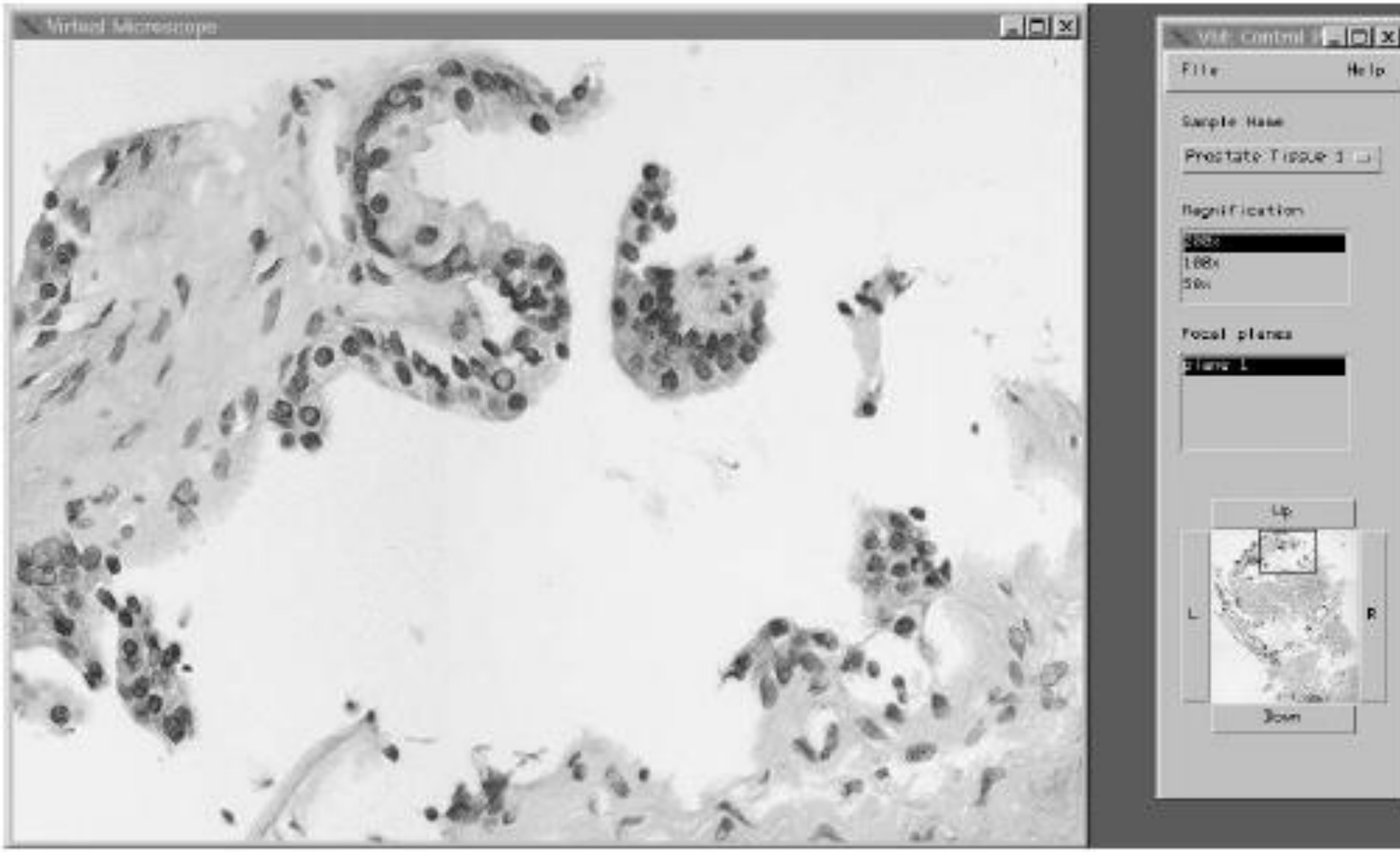
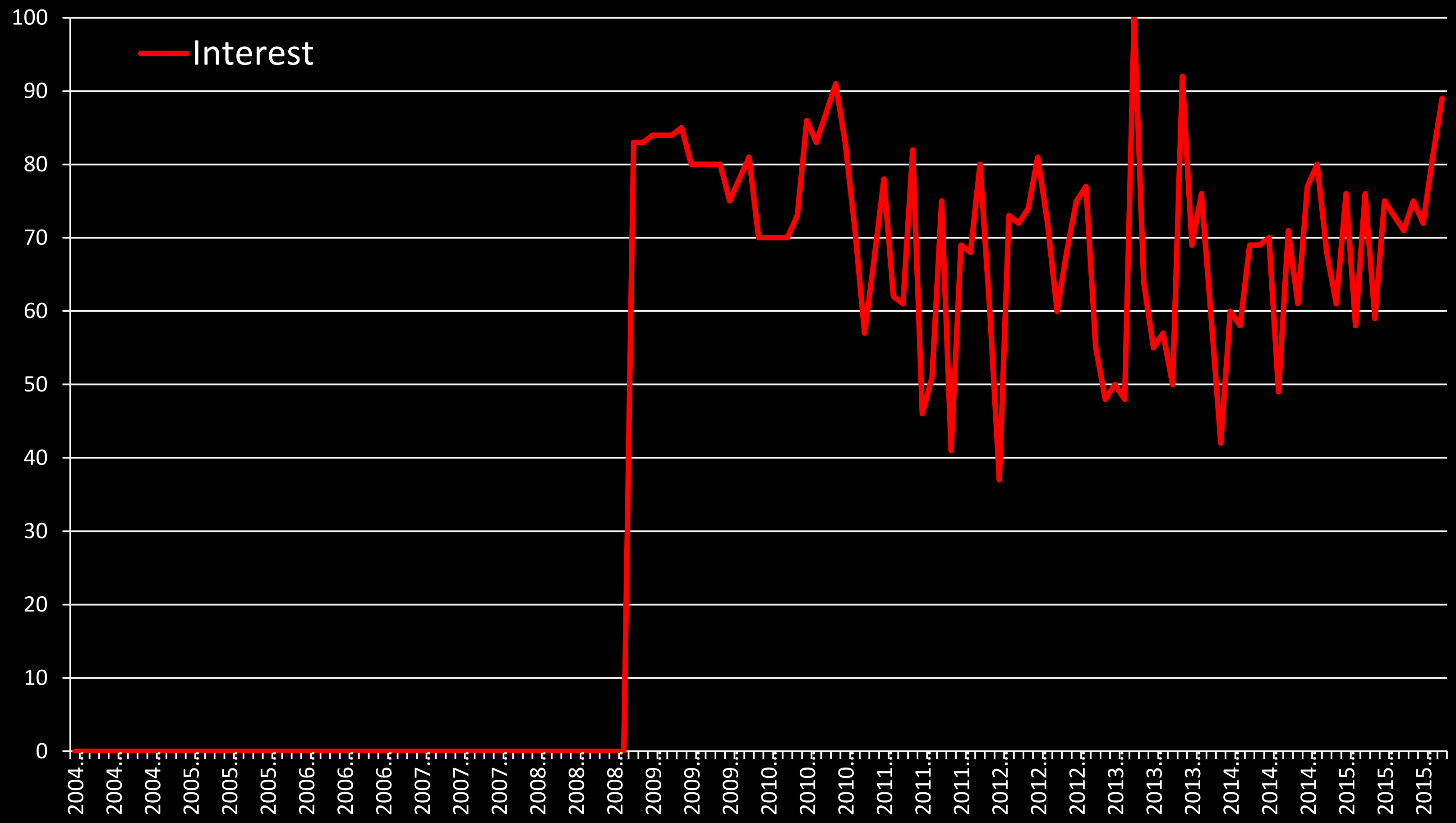


Figure 3: Virtual Microscope client user interface

Proc AMIA Symp. 1998:912-6.

Google Trends: “Digital Pathology”



https://www.google.com/trends/

Current generation slide scanners

All pictures from manufacturers' websites; other slide scanners are available

Vendors

Omnyx (GE/UPMC)
Philips
BioImagene (Ventana)
Aperio (Leica)
Olympus
Nikon
Zeiss
Hamamatsu
MikroScan

3D Histech
TissueGnostics
Motic
Huron Digital Pathology
Others…

Planning an evaluation

Planning

- Define use case(s)
- Identify Stakeholders
- Identify your budget
- Identify candidate hardware/software
- Evaluate candidates

Identify your use case(s)

- The intended use case(s) establish the requirements for hardware and/or software
- Considerable differentiation in current generation of digital pathology products
- No WSI scanner or software package is ideal across all use cases
- <u>Must</u> define use case(s) first

Identify your use case(s)

- Non-clinical
  - Research
  - Education
- Clinical support
  - Clinical conferences
  - Clinical archiving
- Clinical diagnostics
  - Primary diagnosis
  - Secondary diagnosis (consultation)
  - Intraoperative diagnosis
  - Image analysis

Research

- Whole slide imaging and image analysis are well-established in research
  - Pathology and pathobiology
  - Veterinary pathology
  - Pharmaceutical industry
  - Tissue microarray (TMA) review and analysis
  - Telecollaboration

Education

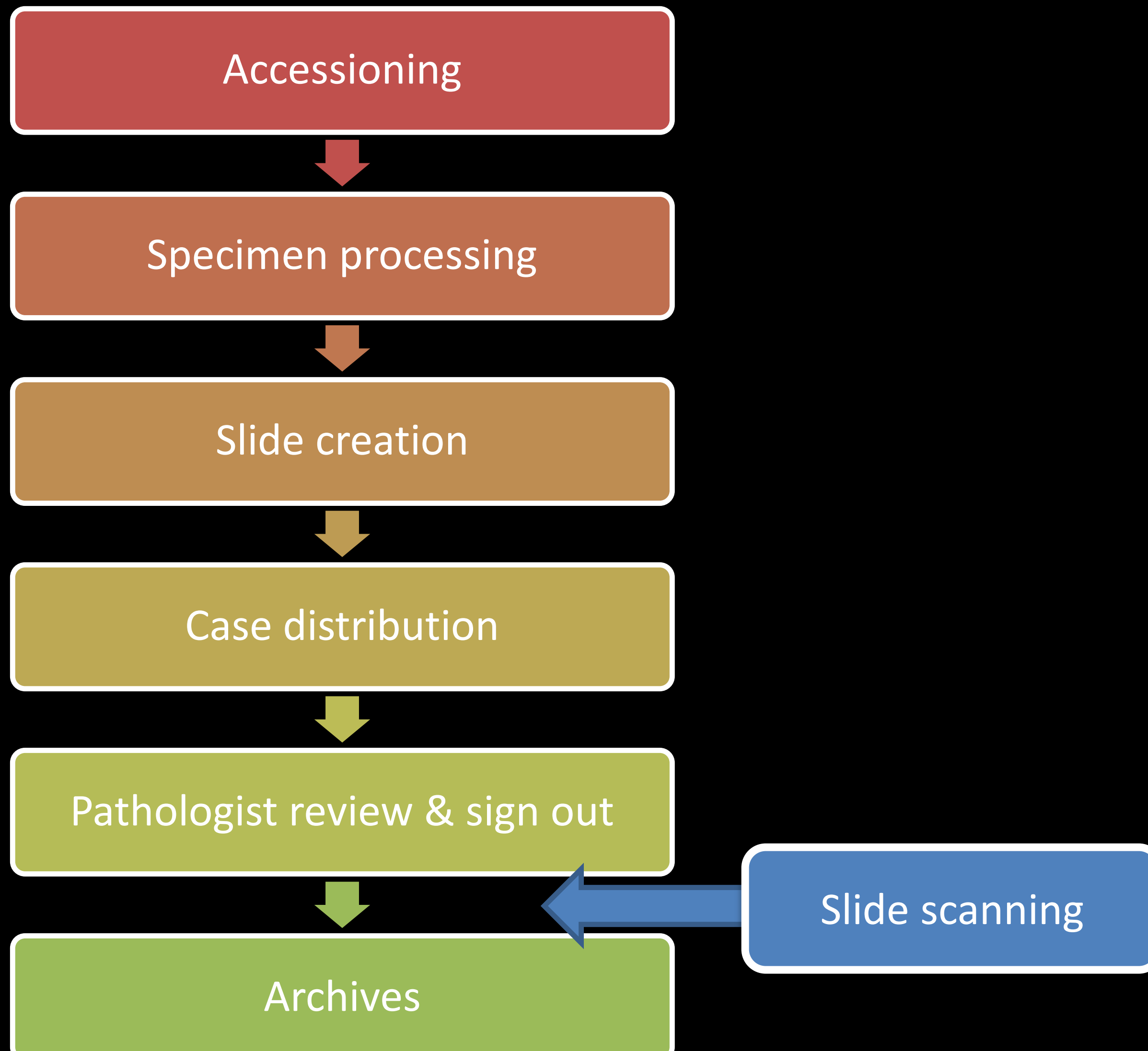
- Whole slide imaging also well-established in education
  - Histology, pathology
  - All levels of training, undergrad to CME

Clinical conferences

- Tumor boards / multidisciplinary conferences

Tot. Breast. 2010 Aug;19(4):284-8.

Clinical slide archiving



Clinical slide archiving: Utrecht

Human Pathology (2010) **41**, 751–757

ELSEVIER

Human
PATHOLOGY

www.elsevier.com/locate/humpath

Original contribution

Creation of a fully digital pathology slide archive by high-volume tissue slide scanning☆

André Huisman PhD[a], Arnoud Looijen MSc[b], Steven M. van den Brink[a], Paul J. van Diest MD, PhD[a,]*

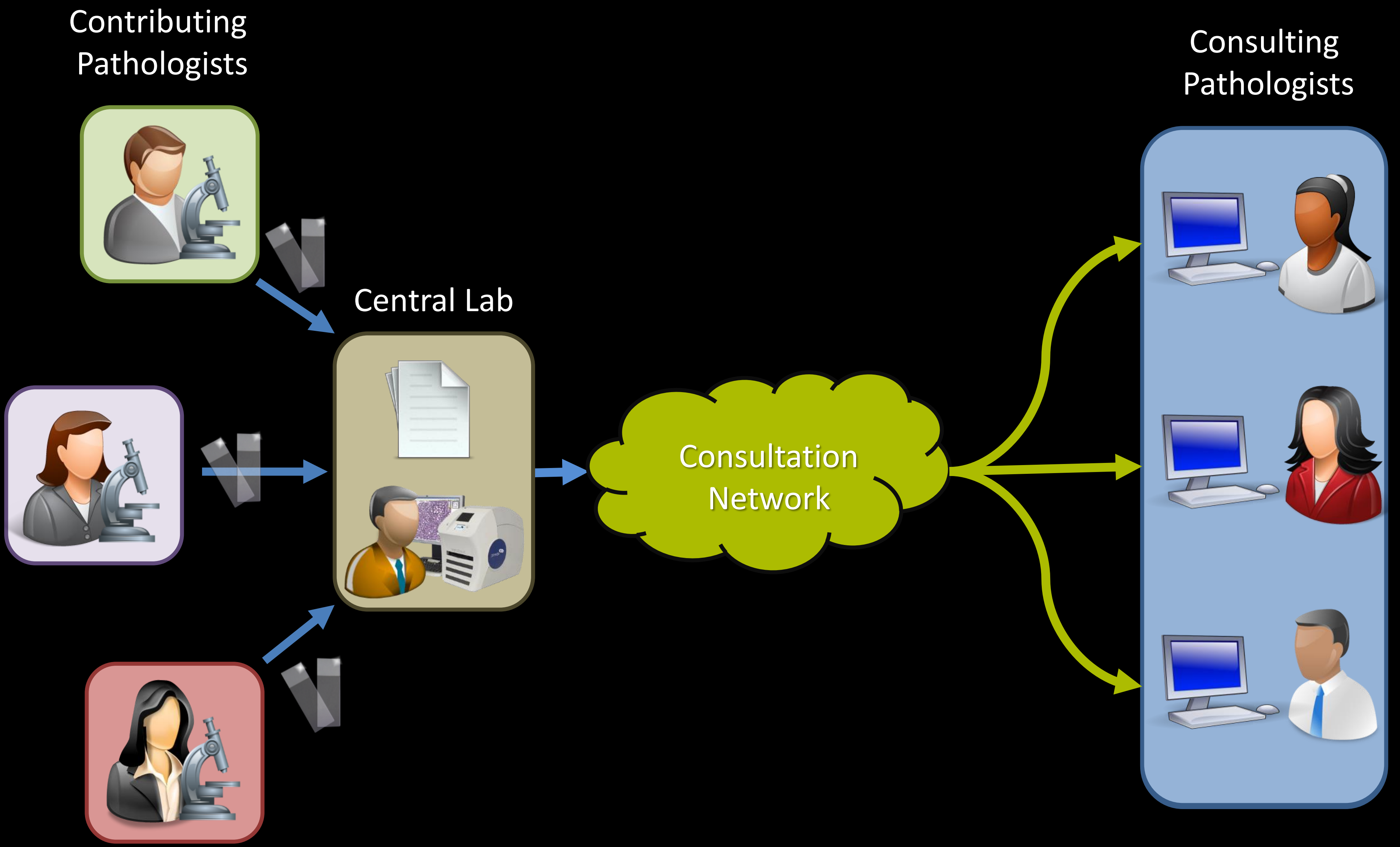
[a]*Department of Pathology, University Medical Center Utrecht, PO Box 85500, 3508 GA Utrecht, The Netherlands*
[b]*Directorate of Information Technology, University Medical Center, 3508 GA Utrecht, The Netherlands*

Received 24 July 2009; accepted 20 August 2009

Secondary (consultative) diagnosis

- Formal or informal diagnostic opinion provided to the primary pathologist
- Typically involves telepathology
- Types:
  - Intra-practice
  - Extra-practice
    - Domestic or international
- Primary pathologist may still review glass

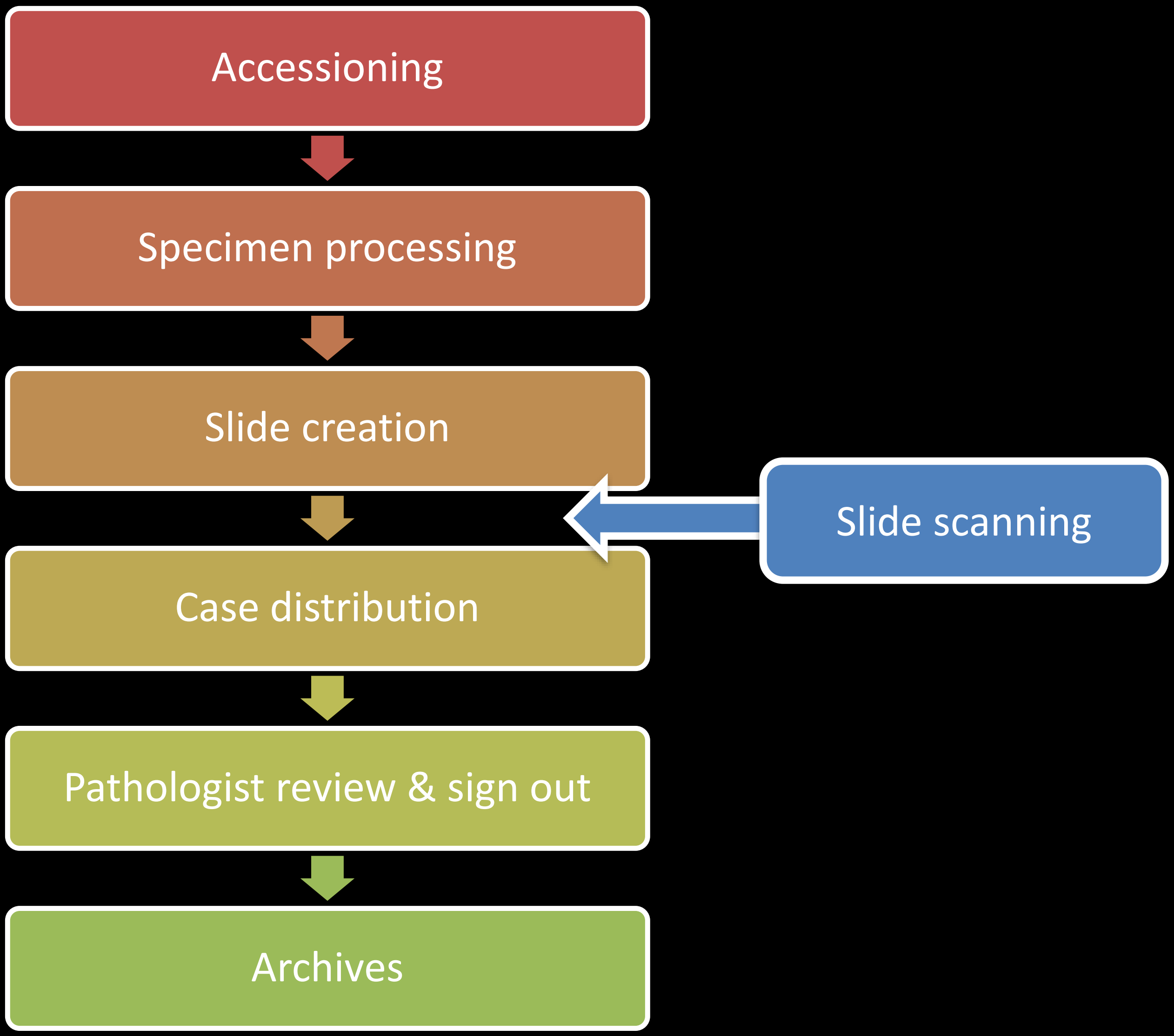
Secondary diagnosis telepathology



Primary diagnosis

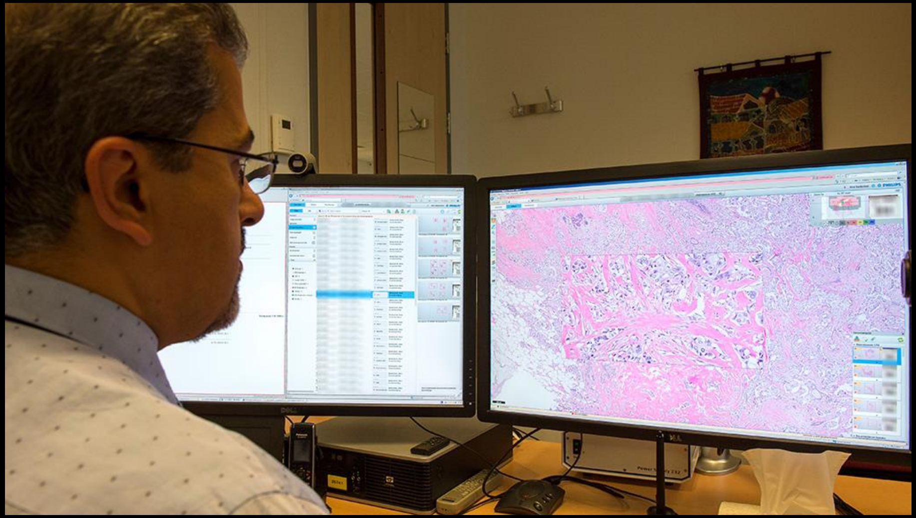
- Rendering of a definitive final diagnosis as the pathologist of record or primary pathologist
- Primary pathologist has the most immediate/direct responsibility to the patient
- No glass reviewed in making the diagnosis

Primary diagnosis



LabPON East Netherlands

- First ***fully digital*** pathology lab in the world
- Philips IntelliSite Pathology Solution
- Live in July 2015 (project initiated in 2012)
- 54,000 cases/year
- > 300k slides/year
- 17 pathologists



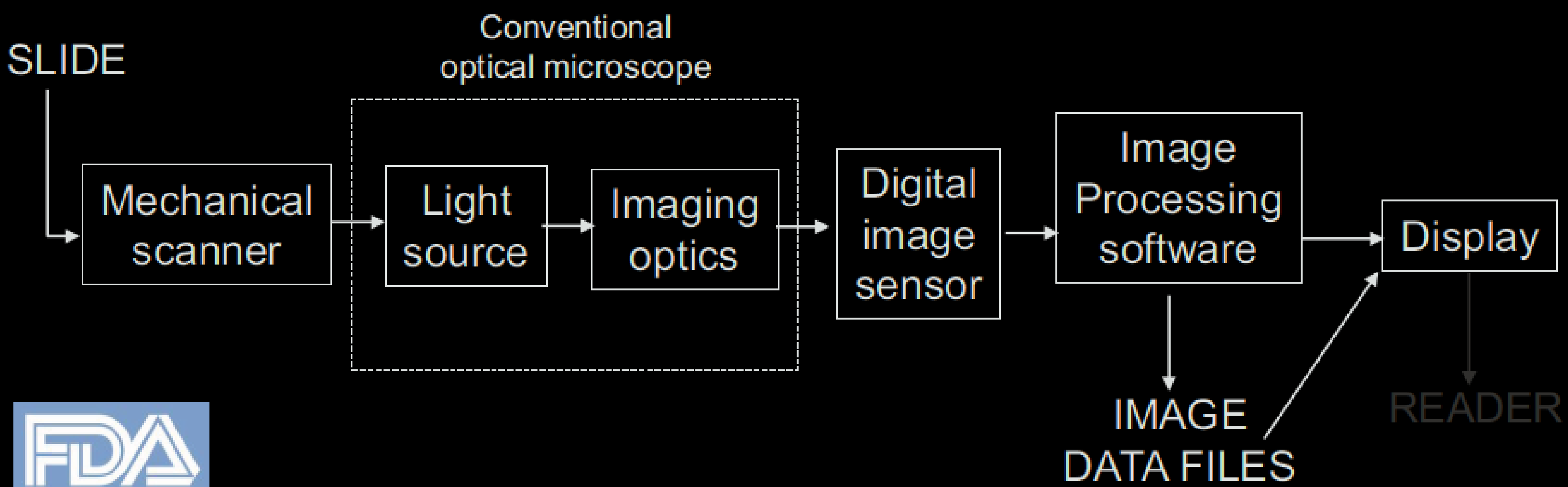
meanwhile in the United States…

Primary diagnosis: FDA

- FDA has indicated it considers digital pathology systems to be Class III devices when used for <u>primary diagnosis</u>

- Class III
  - Insufficient data to assure safety and efficacy
  - Have significant potential for putting patients at risk of injury or death
  - Requires <u>premarket approval</u>

Digital pathology systems



- Entire "systems" will need to gain premarket approval

FDA and Medical Device Regulation

- No manufacturer has yet received FDA approval for primary diagnosis
  - In 2015, the FDA made available a draft guidance entitled “Technical Performance Assessment of Digital Pathology Whole Slide Imaging Devices”
  - This draft, along with public commentary, should help the FDA finalize approval requirements

Technical Performance Assessment of Digital Pathology Whole Slide Imaging Devices

Guidance for Industry and Food and Drug Administration Staff

Document issued on: April 20, 2016

The draft of this document was issued on February 25, 2015

U.S. Department of Health and Human Services
Food and Drug Administration
Center for Devices and Radiological Health

Office of *In Vitro* Diagnostics and Radiological Health
Division of Molecular Genetics and Pathology
Molecular Pathology and Cytology Branch

FDA Regulation

- WSI systems must be labeled as Research Use Only (RUO) in the United States
- FDA has not expressed interest in regulating either secondary (consultative) diagnosis or interoperative diagnosis

Identify your use case(s)

- Non-clinical
  - Research
  - Education
- Clinical support
  - Clinical conferences
  - Clinical archiving
- Clinical diagnostics
  - Primary diagnosis
  - Secondary diagnosis (consultation)
  - Intraoperative diagnosis
  - Image analysis

Identify stakeholders

Identify stakeholders

- Pathologists
  - Local
  - Remote?
- Lab technical staff
  - Histotechnologists
  - Imaging specialists?
- IT/LIS staff
  - Desktop and application support
  - Networking and security

Budget

Budget

- Scanners are expensive, but represent only a portion of the TCO for digital pathology

- $25k to $300k per scanner
- Maintenance and support contracts
  - 10-15% of purchase price annually
- Technician salaries
- Network and data storage costs

Cost estimate

- For a full digital conversion at one large academic institution:
  - Initial hardware and software: $2 million
  - Annual support personnel: $650,000
  - Annual image storage: $10,000

- Isaacs et al. *J Pathol Inform.* 2011;2:39

Scanners required to normalize TAT

Scanner speed: 60 – 180 s/slide	
No Scanner	**WSI = 9**
10.40 hrs	10.5 hrs

Scanner speed: 90 – 180 s/slide	
No Scanner	**WSI = 10**
10.40 hrs	10.5 hrs

Scanner speed: 60 – 240 s/slide	
No Scanner	**WSI = 11**
10.40 hrs	10.5 hrs

Scanner speed: 120 – 240 s/slide	
No Scanner	**WSI = 13**
10.40 hrs	10.5 hrs

Anal Cell Pathol (Amst). 2012;35(1):57-64

WSI storage costs

- Varies with the intended use case
- Retention of digital slides
  – CAP says 10 years for glass slides
  – CAP has provided no guidance for digital slides
- Consider cost for primary data and backup

Declining storage costs (?)

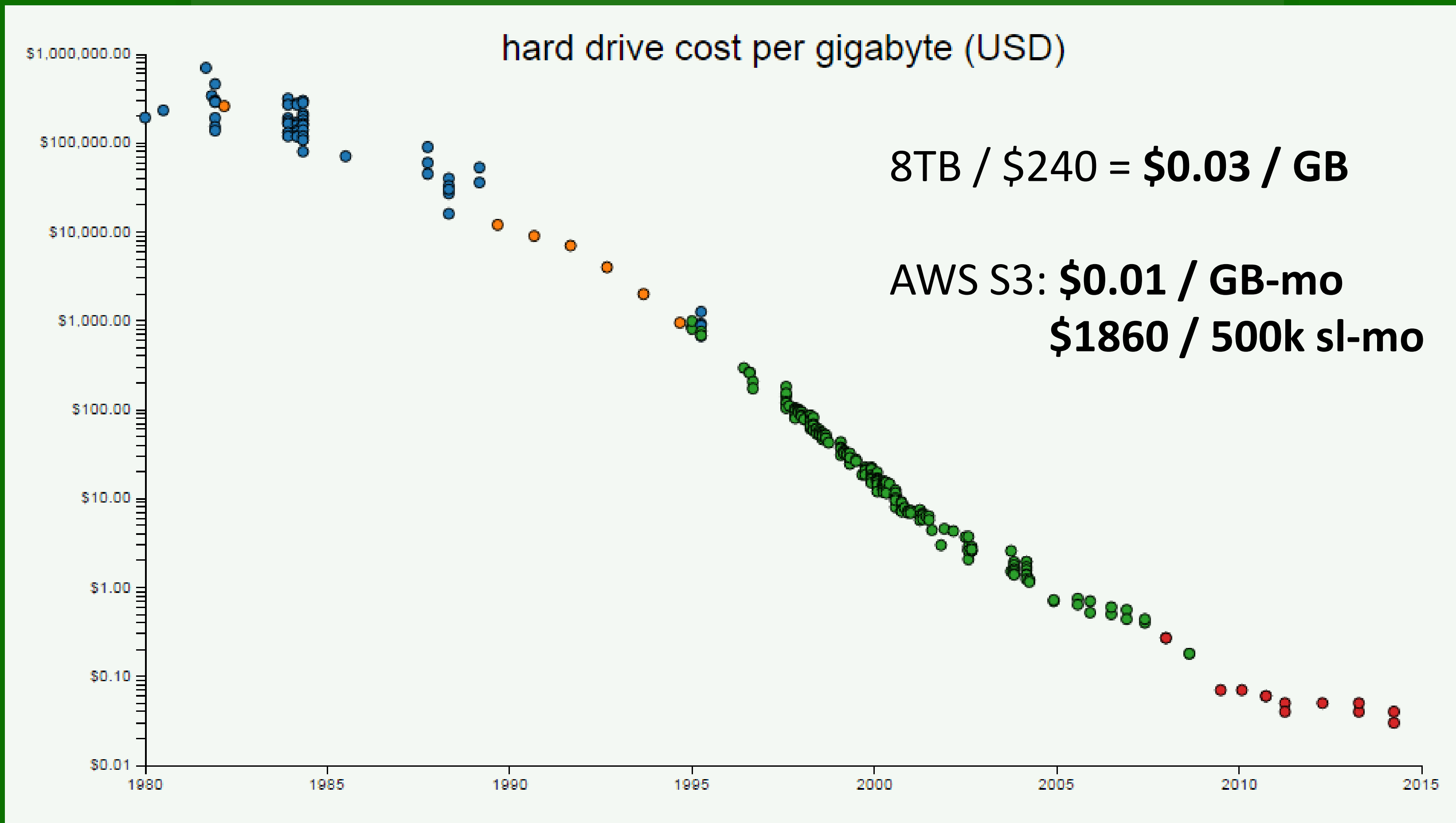
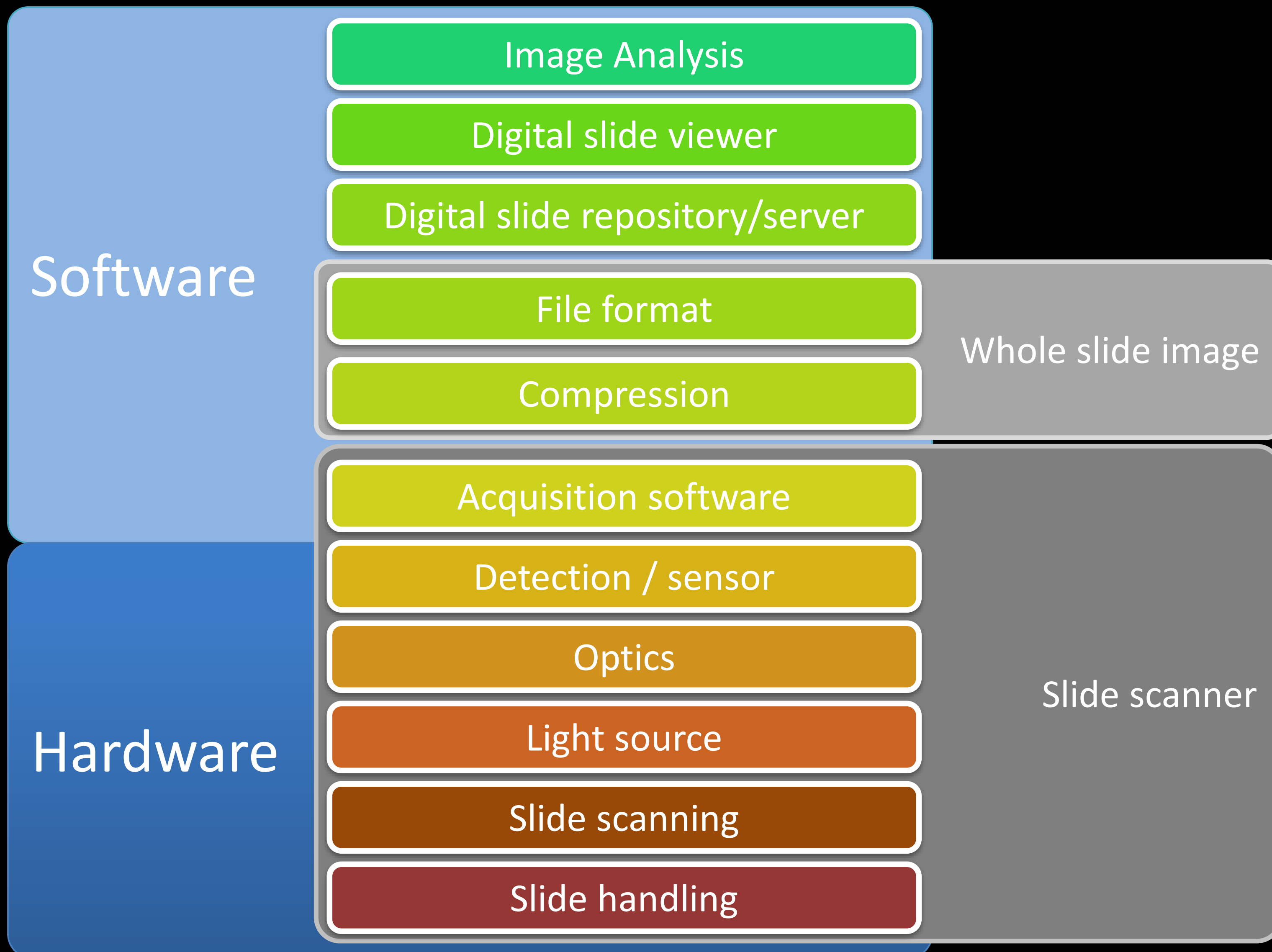


Chart Last Updated: March 9, 2014 - This graph of hard drive cost, plotted on a logarithmic scale, shows the precipitous drop in prices that occurred over 35 years of innovation and increasing demand. Roll your cursor over each datapoint to see more information. Static versions of this image are also available: small, large. Read below for sources.

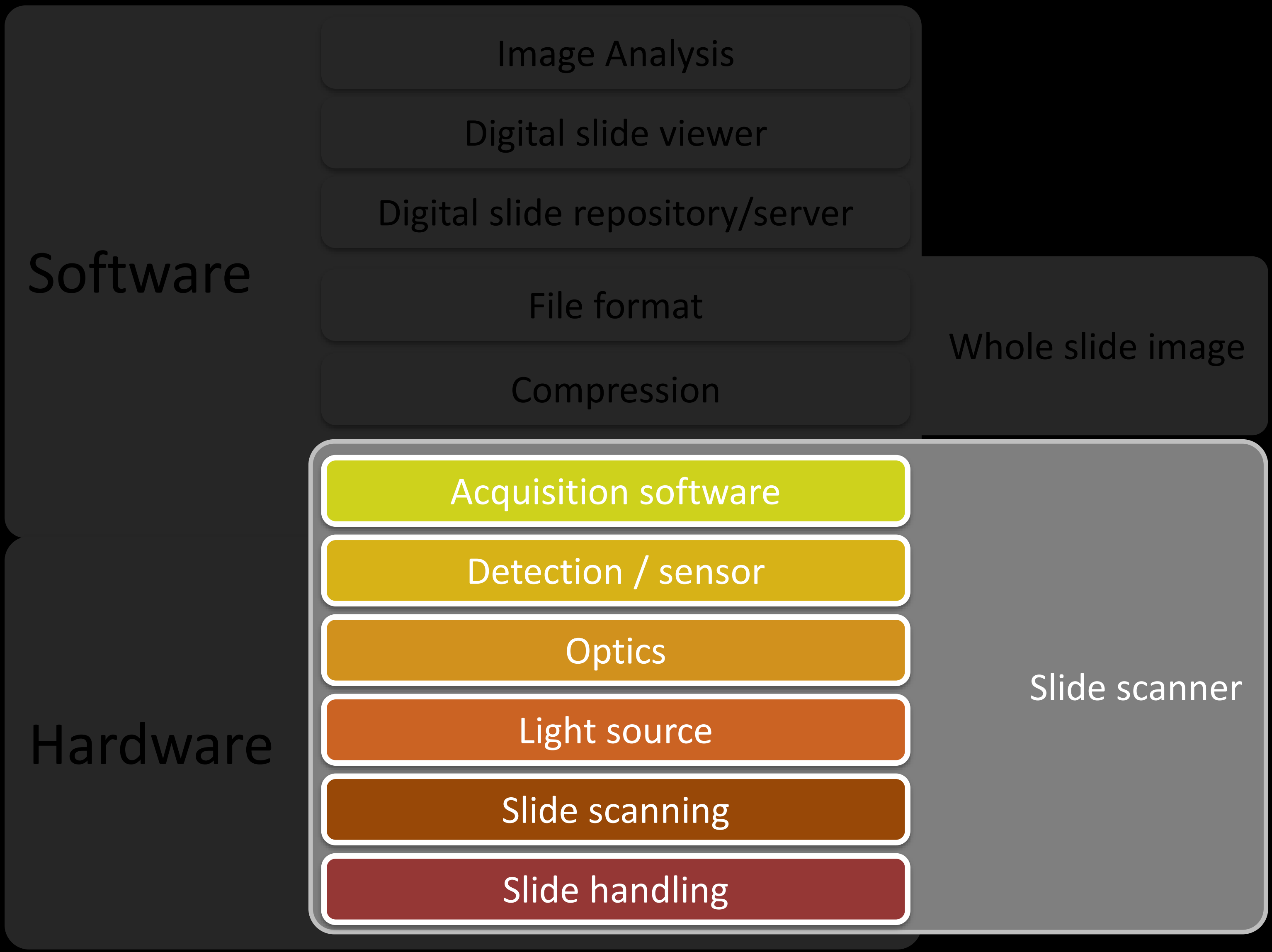
Source: Matt Komorowski, http://www.mkomo.com/cost-per-gigabyte-update

Comparing WSI systems

WSI: A layer model



WSI: A layer model



Comparing WSI slide scanners

- Slide handling
- Slide scanning method
  - Focusing strategy
  - Z-stacking
- Light source
- Optics
  - Single objective v. multiple objectives
- Detection / sensor
  - “Equivalent magnification” vs. spatial resolution

Slide handling

Slide Handling

- Slide handling
  - Single slide/stage
  - Standalone autoloaders (“hotels”)
  - Slide trays
  - Slide magazines




Slide handling, cont.

- Slide magazines tend to support higher throughput/higher capacity:
  - Does the scanner support continuous loading?
  - Does the scanner support changing scan priority?

- Slide trays are lower throughput/lower capacity but have advantages:
  - Fewer moving parts
  - Support different slide formats, like 2” x 3” slides
  - Better suited for use with fresh/wet slides (e.g. frozen sections)

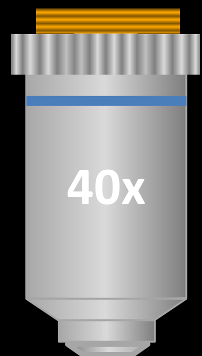
Slide scanning

Slide scanning

- Two approaches to scanning a slide:
  - Tiling (Bacus patents)
  - Line scanning (Aperio patents)

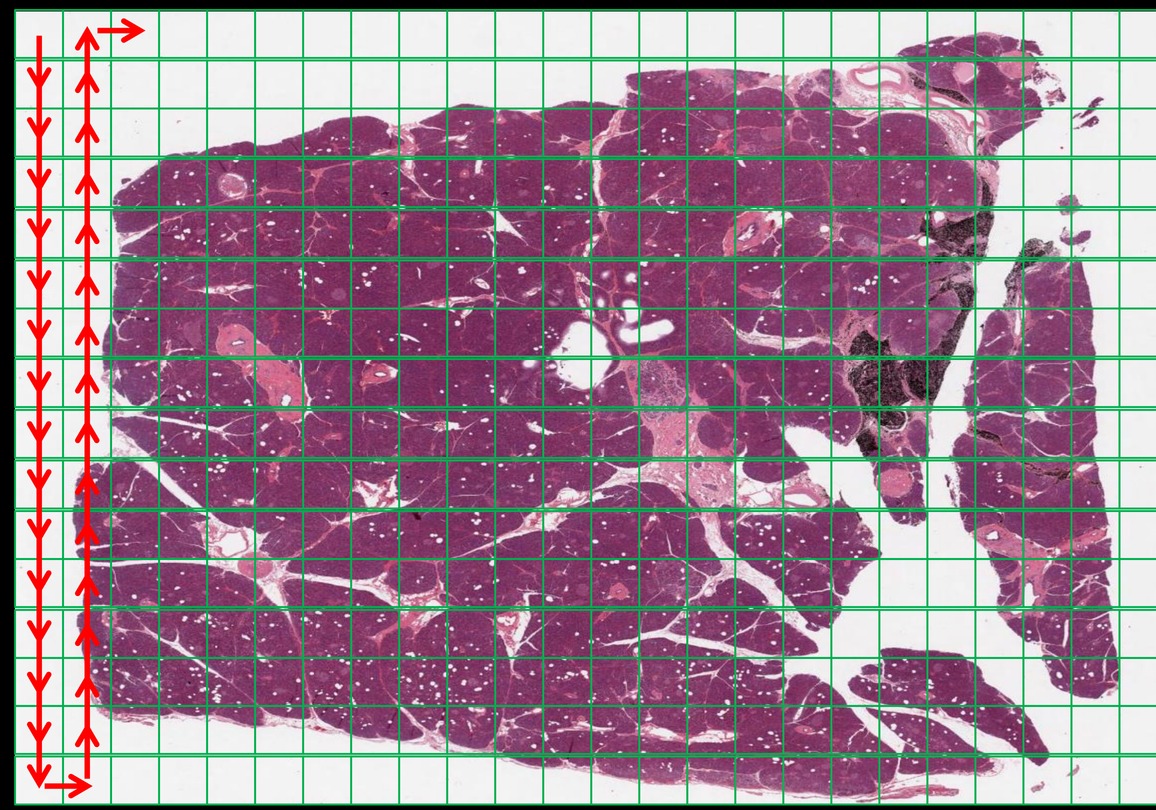
- In both cases, the resulting images (tiles or strips) are fitted together into a single large image, i.e. the whole slide image by the acquisition software

Tiling

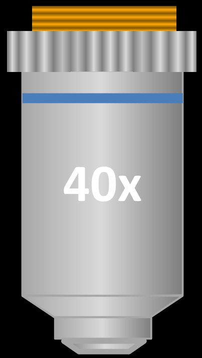


- The slide is scanned as a series of rectangular tiles

- The tiles are assembled into a WSI either concurrently or after the scanning is finished

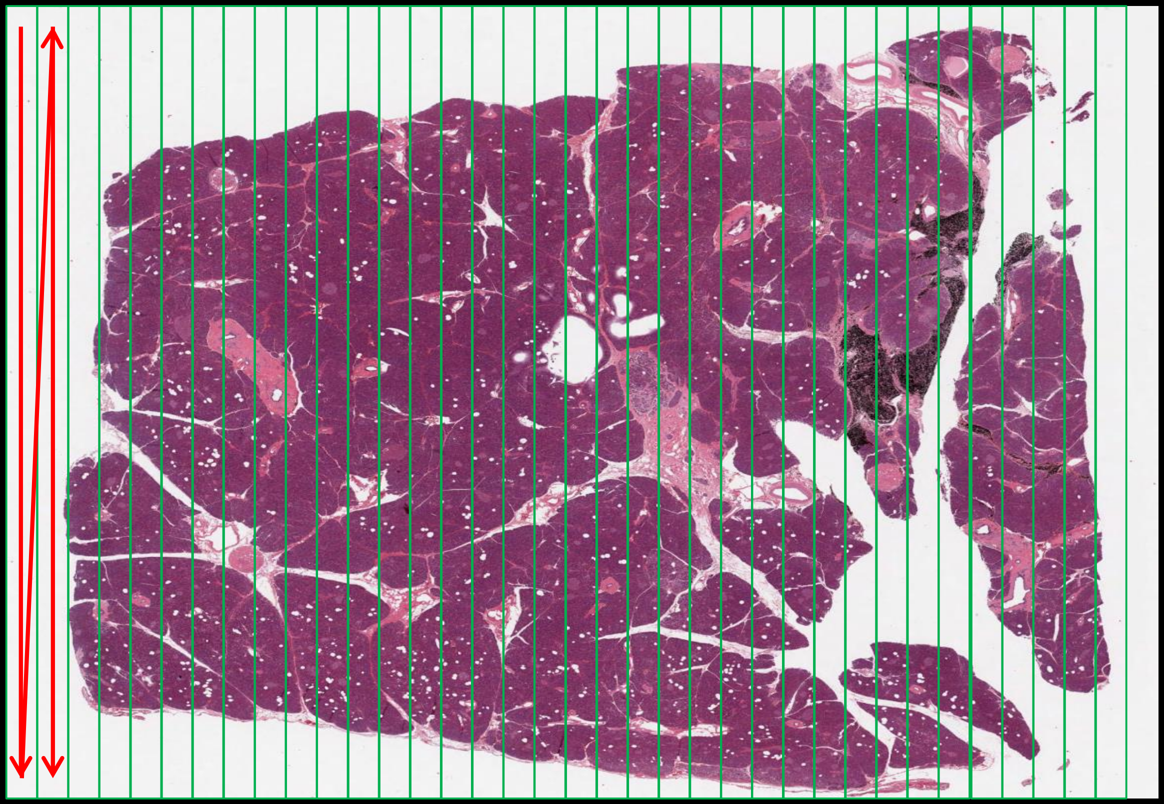


Line scanning



- The slide is scanned as a series of long, narrow strips

- The strips are assembled into a WSI either concurrently or after the scanning is finished



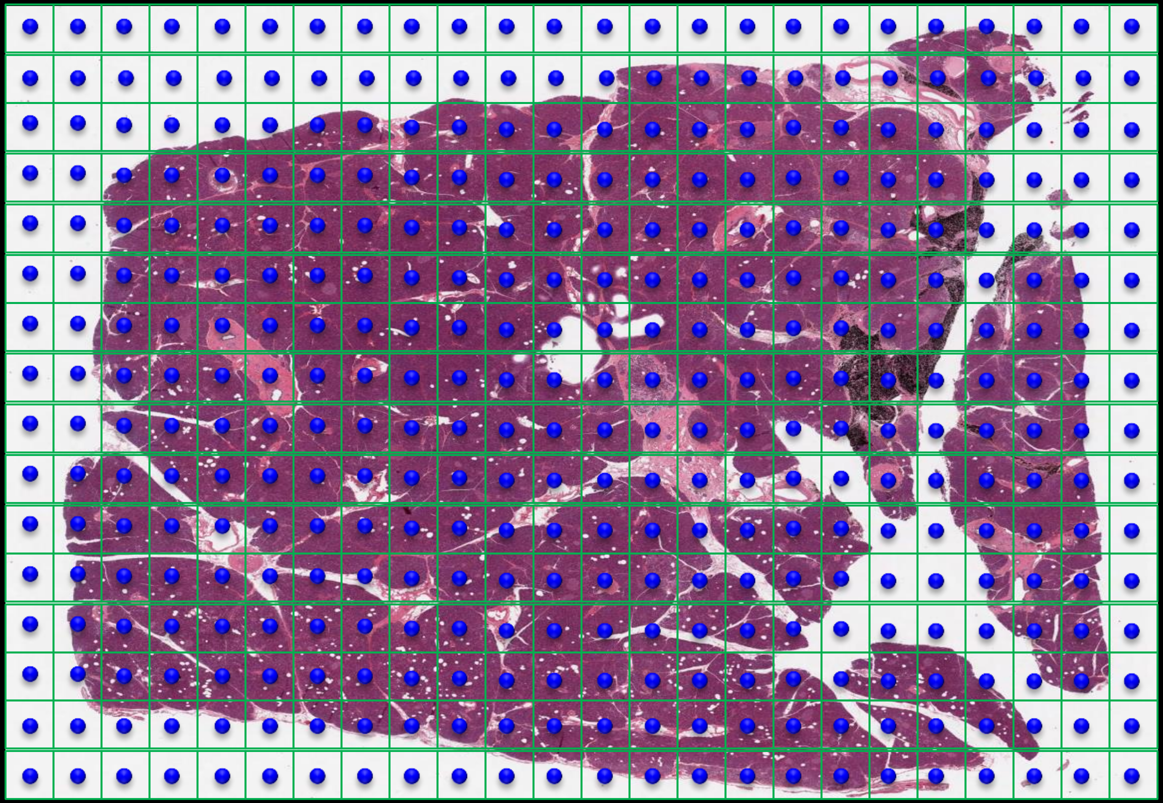
Focus strategy

Focusing

- All WSI scanners attempt to produce a single "best focus" image plane
- Several strategies that a scanner might employ
- Usually speed is traded for quality (and vice versa)

Focus strategy: focus every field

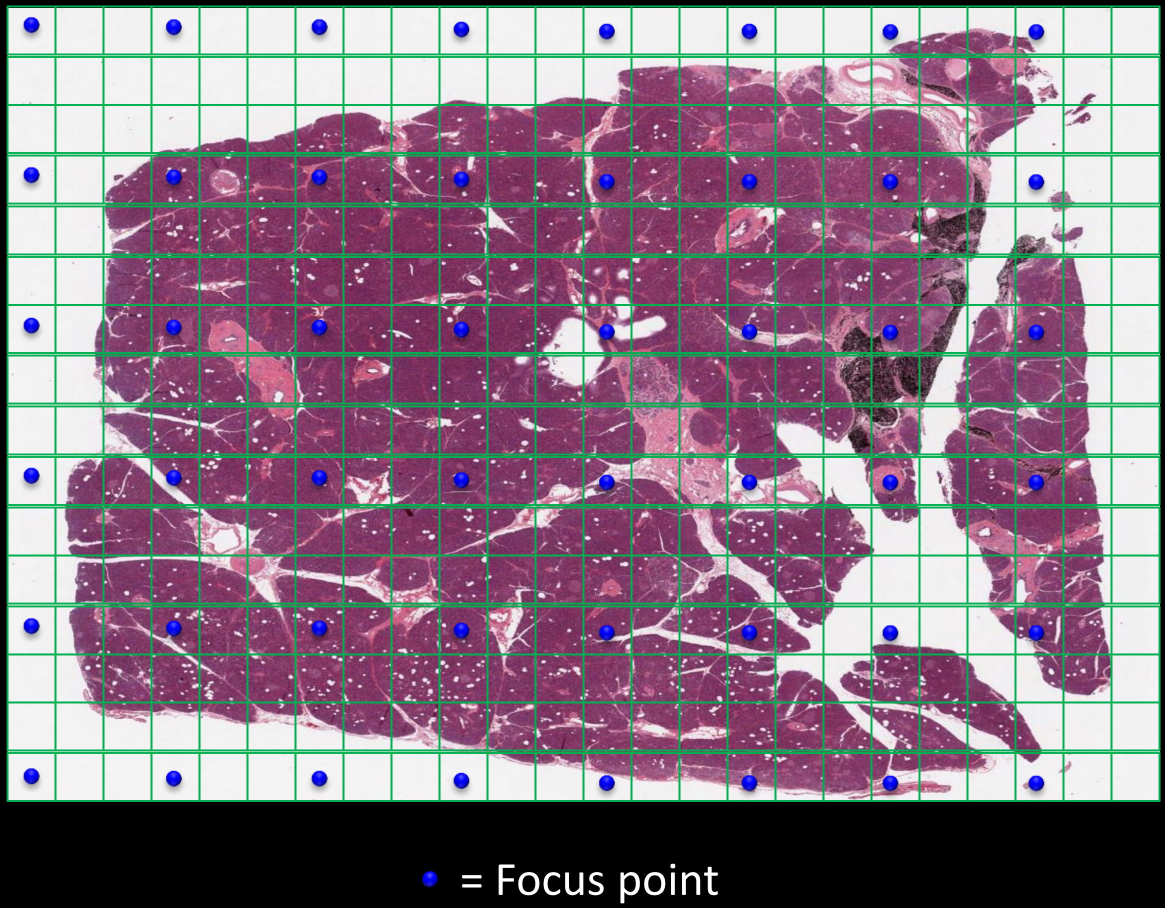
- Usually associated with tiling
- After moving the stage, each field is autofocused and the tile is imaged
- Time consuming, ?more accurate



= Focus point

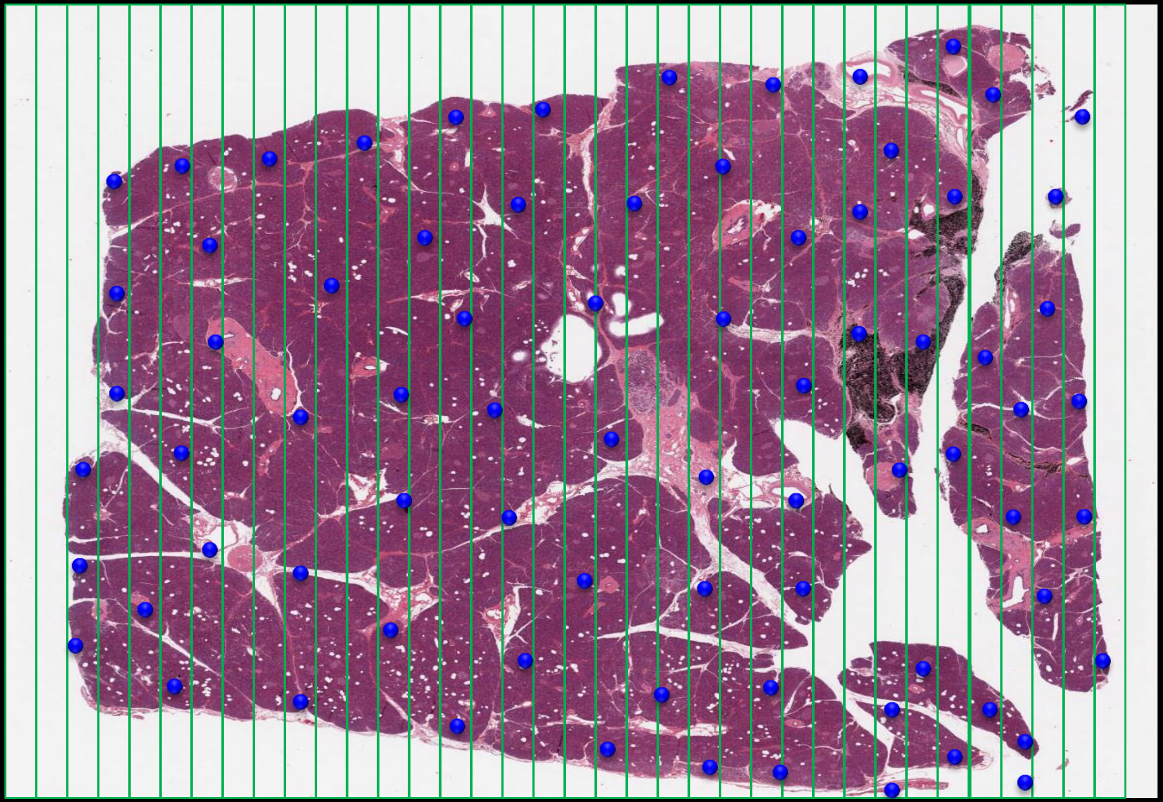
Focus strategy: focus n^{th} field

- Usually associated with tiling
- Autofocusing occurs every n^{th} field
- Faster, simpler
- Placement of focus points lacks context



Focus strategy: focus map

- Used with line scanning or tiling
- Focus points are distributed over the tissue forming a surface
- Focus is calculated for intervening tissue
- Faster, ?less accurate

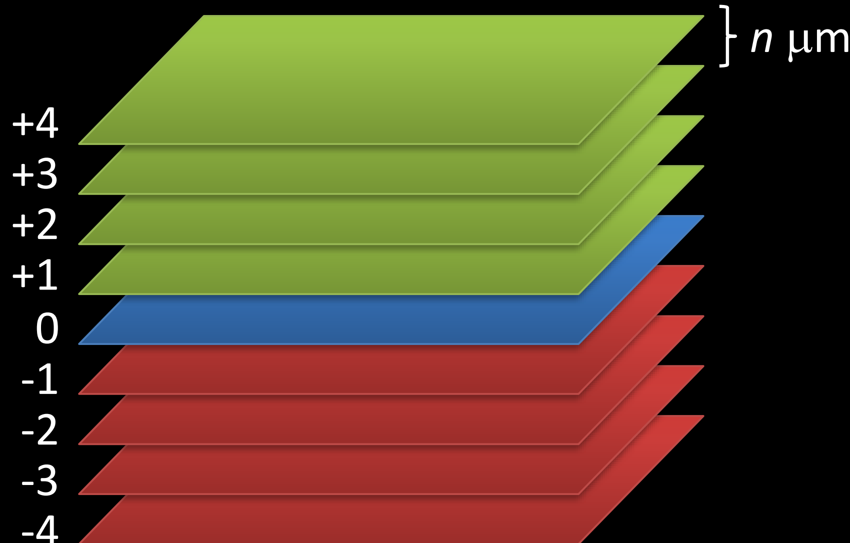


= Focus point

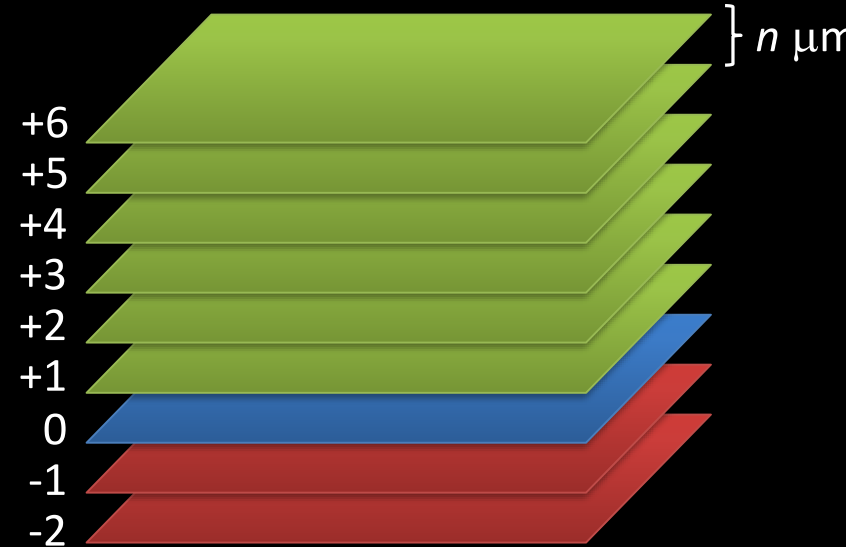
Z-stacking

- Z-stacking is the process of capturing multiple planes above and below the “optimal” focal plane
- These planes can all be kept to allow “focusing” through the specimen later
  - May be desirable for thick specimens
- Alternatively “in focus” information from the planes can be combined algorithmically to create a single “extended depth of focus” image

Z-stacking



Symmetrical



Asymmetrical

Light sources

Light sources

- Traditionally halogen or xenon bulbs were used for WSI scanners
- Most vendors are moving to LED light sources
- Considerations:
  - Lifetime of bulb
  - Fluctuation in output over time
  - Implications for calibration

Optics

Optics

- WSI scanner optics are similar but not identical to microscope optics

- Most scanners have a <u>single microscope objective</u>
  - Typically a high quality 20x or 40x objective
  - Combined with additional lenses to produce the final magnification

- Scanners designed for live robotic telepathology usually have multiple objectives

Multiple objectives

http://www.mikroscan.com/whole-slide-scanners/mikroscan-sl5/

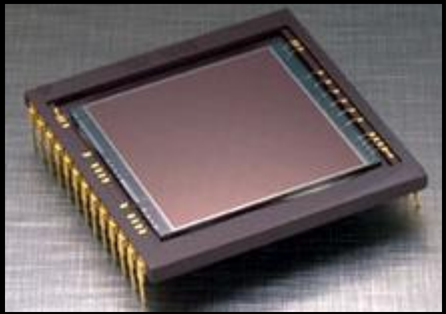
Other optical configurations

- Scanners with oil-immersion objectives are available from a small number of vendors
- Likewise, scanners with very higher power objectives (60x, 100x) are also available

Detection

Detection / sensor

- Brightfield scanners use CCD or CMOS chips
- These chips have a grid of “wells” that accumulate photons to create an image
- The wells correspond to pixels and can vary in size from chip-to-chip



Detection / sensor cont.

- Ultimately, the spatial resolution of a scanner depends on <u>both</u> total magnification and imaging sensor pixel size

- In a nutshell, there is no such thing as a “20x scan” or a “40x scan”

- It’s more complicated than that

Digital resolution examples

	20x	40x
Aperio AT	0.50 μm / pixel	0.25 μm / pixel
Philips UFS		0.25 μm / pixel
Omnyx VL 120	0.275 μm / pixel	0.138 μm / pixel

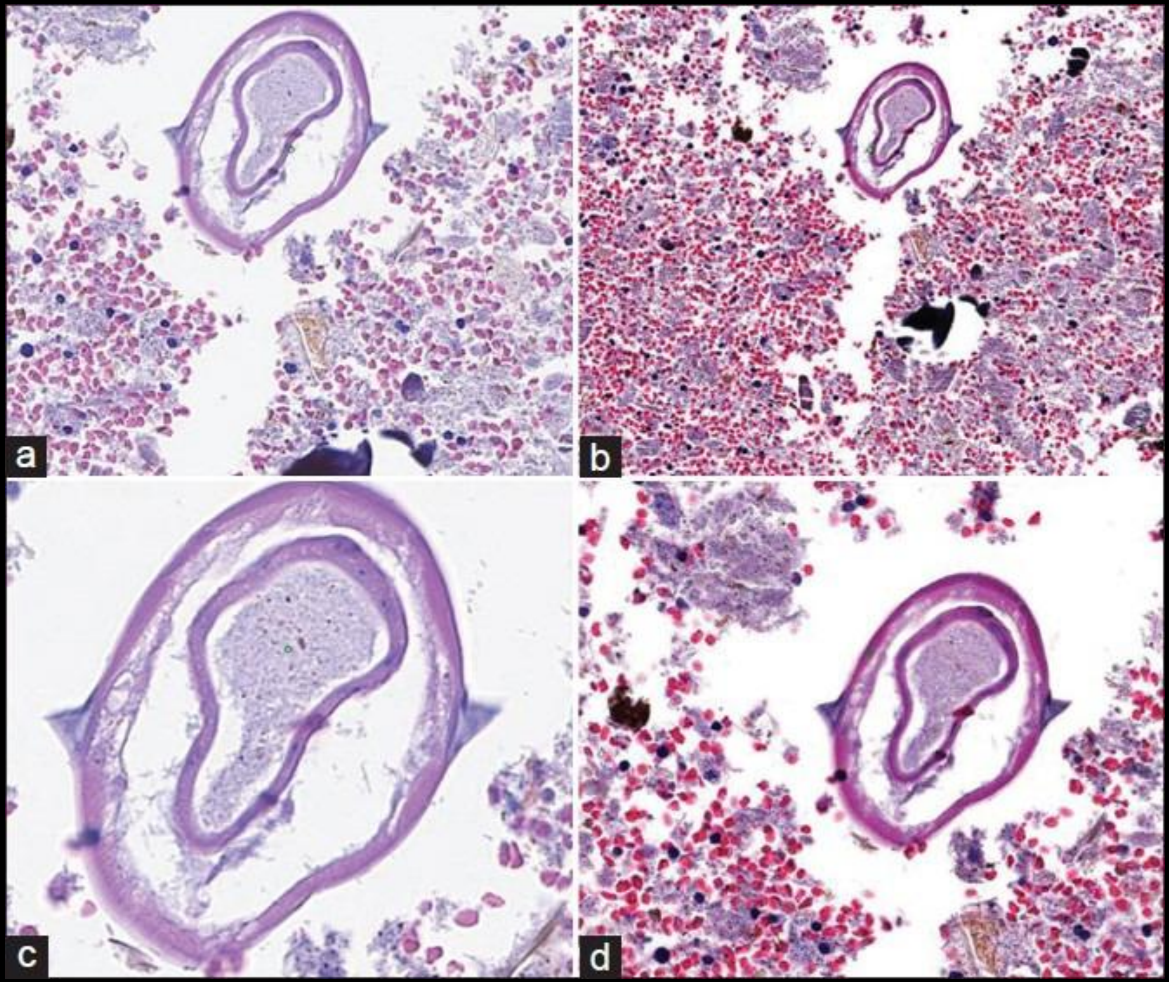
For more information: Sellaro TL, et al. Relationship between magnification and resolution in digital pathology systems. *J Pathol Inform*. 2013 Aug 22;4:21

Example: “20x” image of enterobius

5.5 μm pixel | 10 μm pixel

Full

Cropped

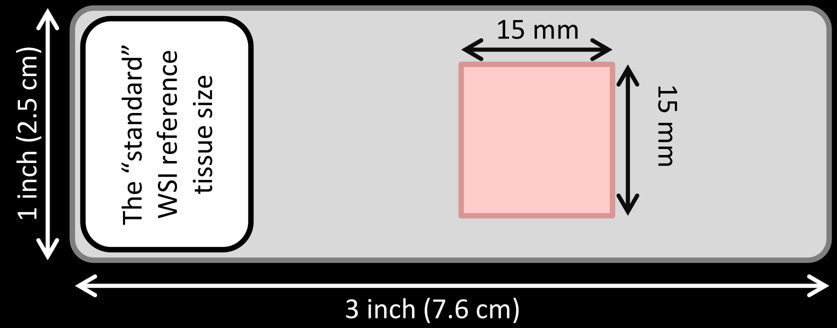


Sellaro TL, et al. J Pathol Inform. 2013 Aug 22;4:21

Scan speed

Scan speeds

- Vendors tend to quote scan speeds in terms of a 15 mm x 15 mm piece of tissue and at a particular "magnification equivalent" (e.g. 20x, 40x)



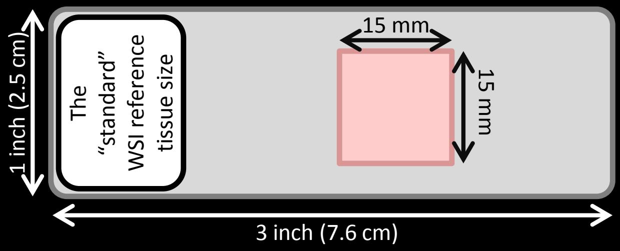
Scan speeds, cont.

- All quoted scan times include the time to collect image data on a single plane on the slide in the given area (typically 15 x 15 mm)
- What might not be included:
  - Time to acquire focus points
  - Time to switch from one slide to the next
  - Time to compress the image data and create the WSI
  - Use of a “high quality” mode for better scans
- What is definitely not included:
  - Acquisition of additional image planes (z-stacks)
  - Time to load/unload scanner
  - Time to QA review the slide
  - Other overhead

Scan speeds

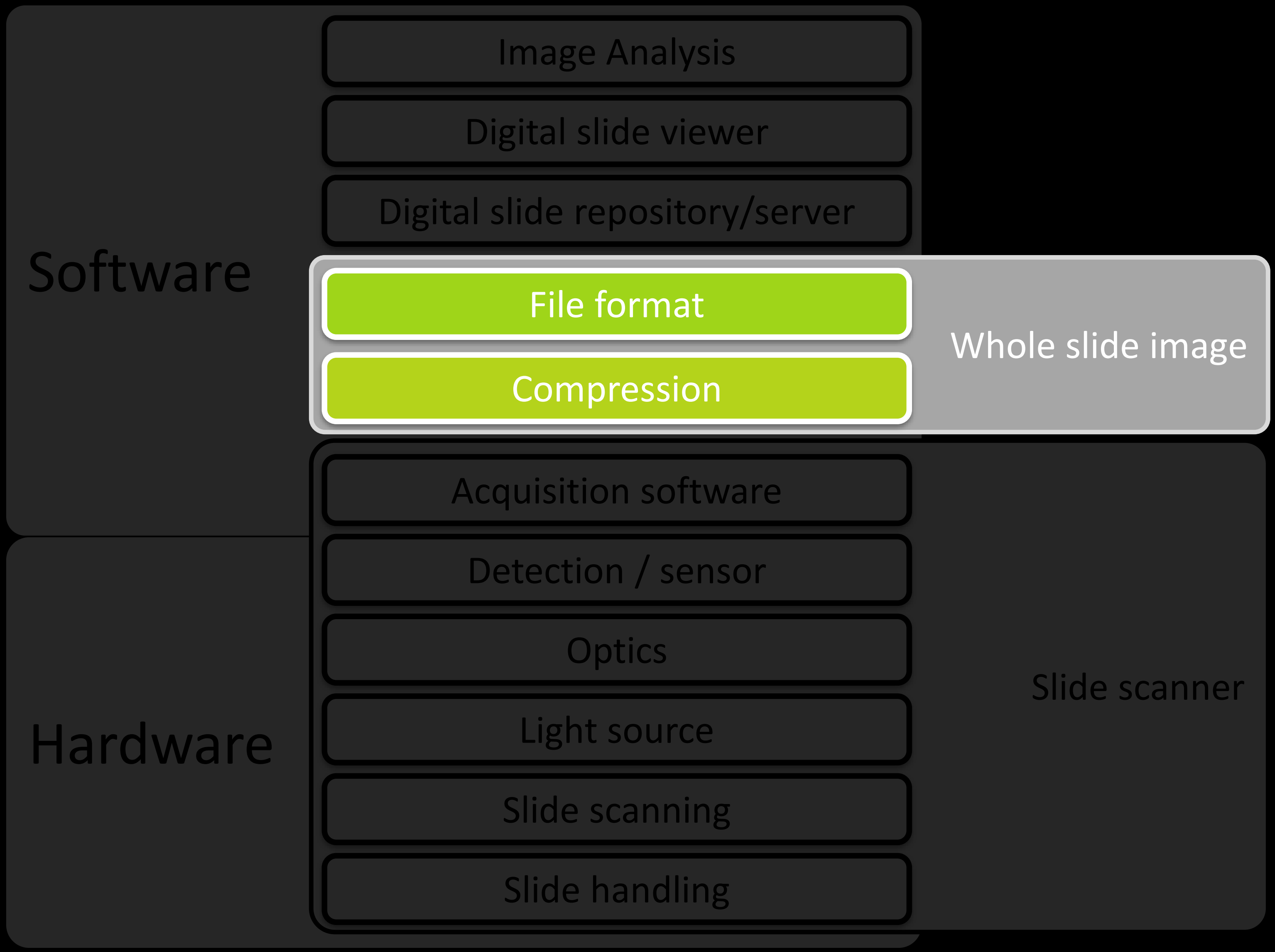
	20x	40x
Aperio AT	90 sec	270 sec
Ventana iScan	45 sec	
Huron TissueScope HS	30 sec	
Philips UFS		60 sec

According to manufacturer;
15 mm x 15 mm scan area



WSI file formats

WSI: A layer model

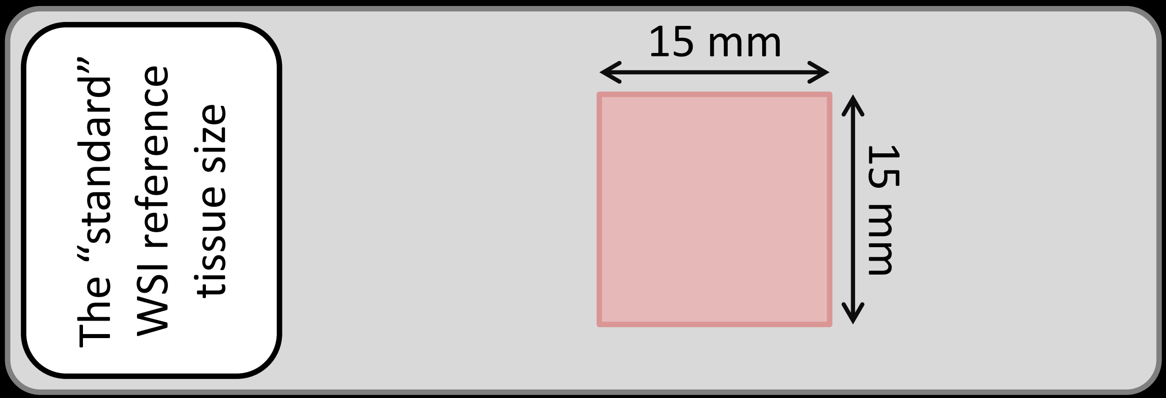


WSI files

- Once all the image data is acquired, the WSI must be stored on disk
- These files are relatively large

- Typical resolution for images with “equivalent magnification” of:
  – 40x: 0.25 micron/pixel (mpp)
  – 20X: 0.50 micron/pixel (mpp)

WSI file size



- The unofficial "standard" for quoting scan speed and size: 15 mm x 15 mm

WSI file size

- 20x: 0.5 mpp
  - 15 mm x 15 mm = 30,000 x 30,000 micron
    = 30,000 x 30,000 px = 900,000,000 px
    = 225 Mpx
  - 225 Mpx x 24bit/px = <u>2.51 GB</u> uncompressed

- 40x: 0.25 mpp = <u>10.1 GB</u> uncompressed

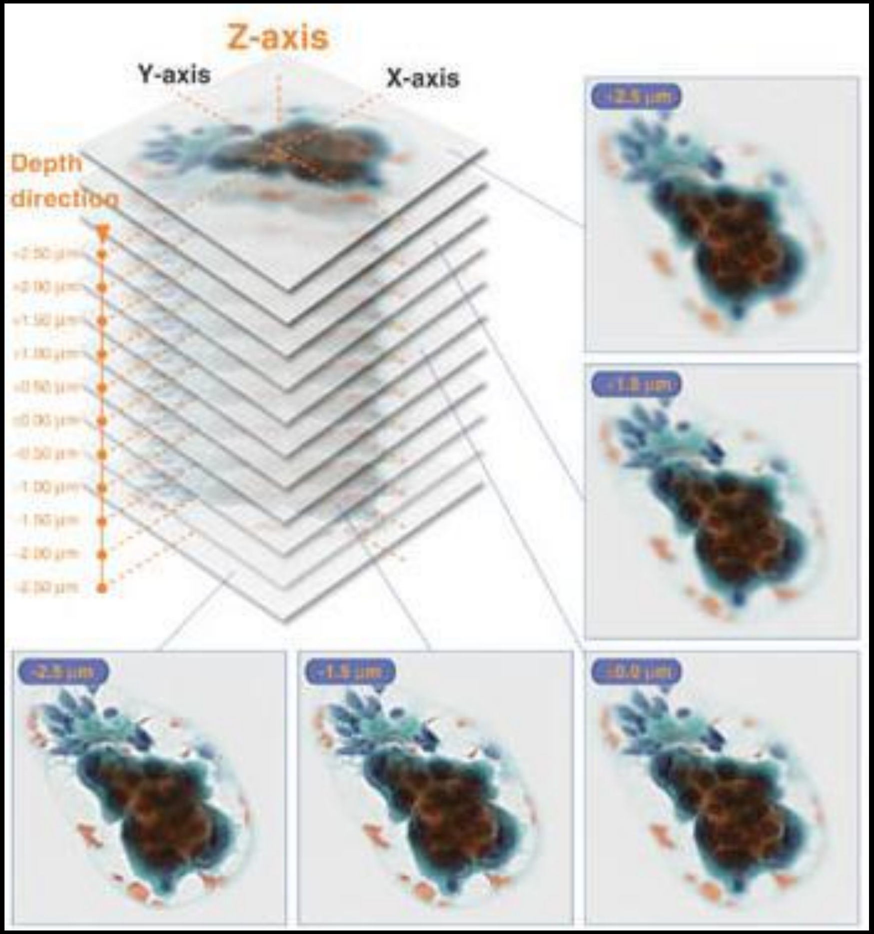
WSI file size

- Due to the large size, WSI data are usually compressed using lossy algorithms
  - Typically JPEG2000 or JPEG
  - Ratios of 1:20 to 1:10 or so

- 20x: 2.51 GB uncompressed
  - ~ <u>128 - 256 MB</u> compressed

- 40x: 10.1GB GB uncompressed
  - ~ <u>502 MB – 1 GB</u> compressed

Z-stacking & WSI file size



- Z-stacks typically increase file size linearly by the number of focus levels saved
- Use sparingly

http://www.hamamatsu.com/jp/en/C9600.html

WSI file formats

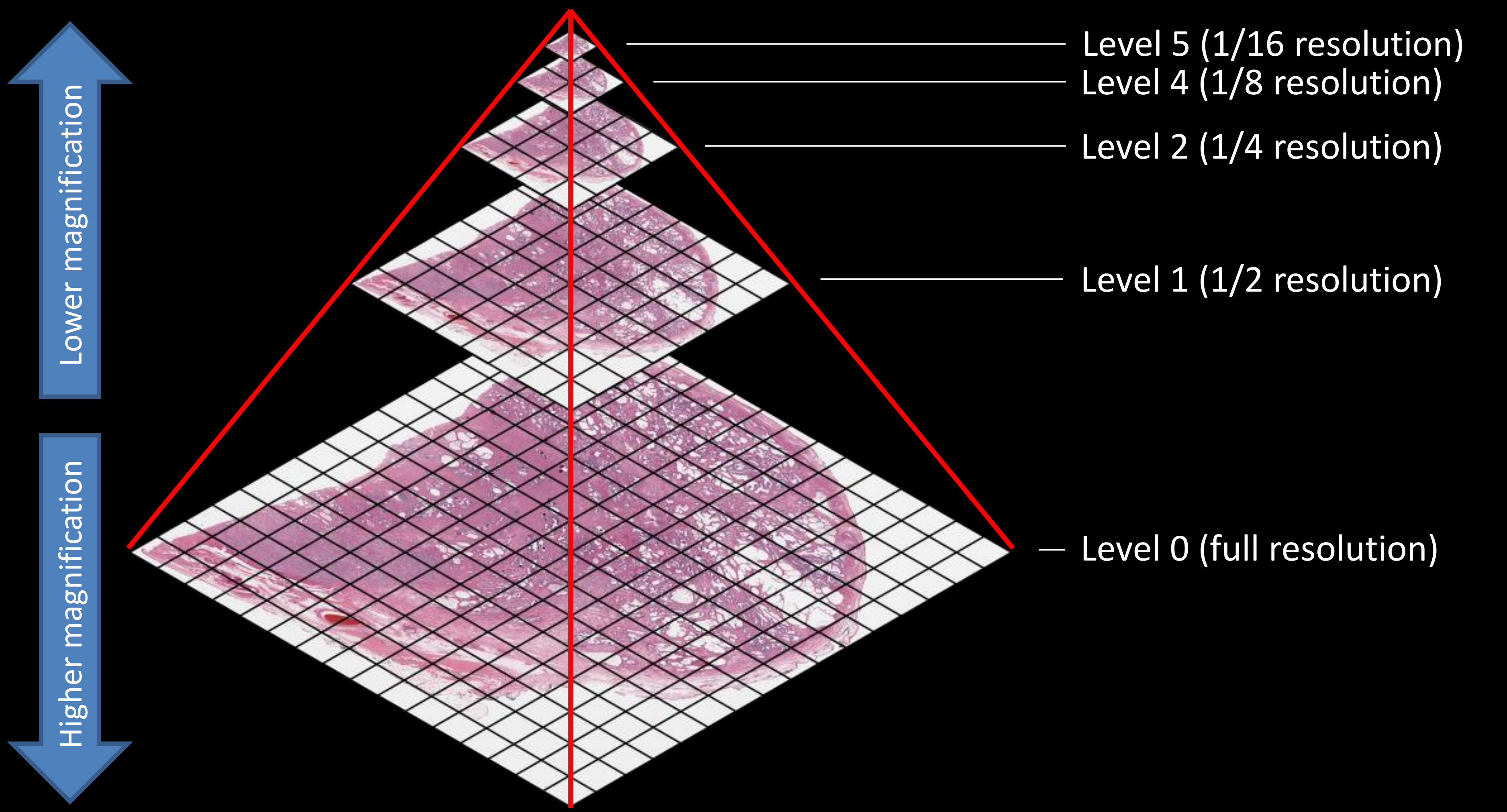
- No standard file format for WSI
- Some non-proprietary/open formats exist
  - DICOM standard (supplement 145) approved in 2010; not in widespread use
  - JP2, the file container for JPEG2000 codestreams
  - TIFF/BigTIFF with JPEG compression
  - Deep Zoom images

- Numerous proprietary formats
- Results in some potential for vendor lock-in

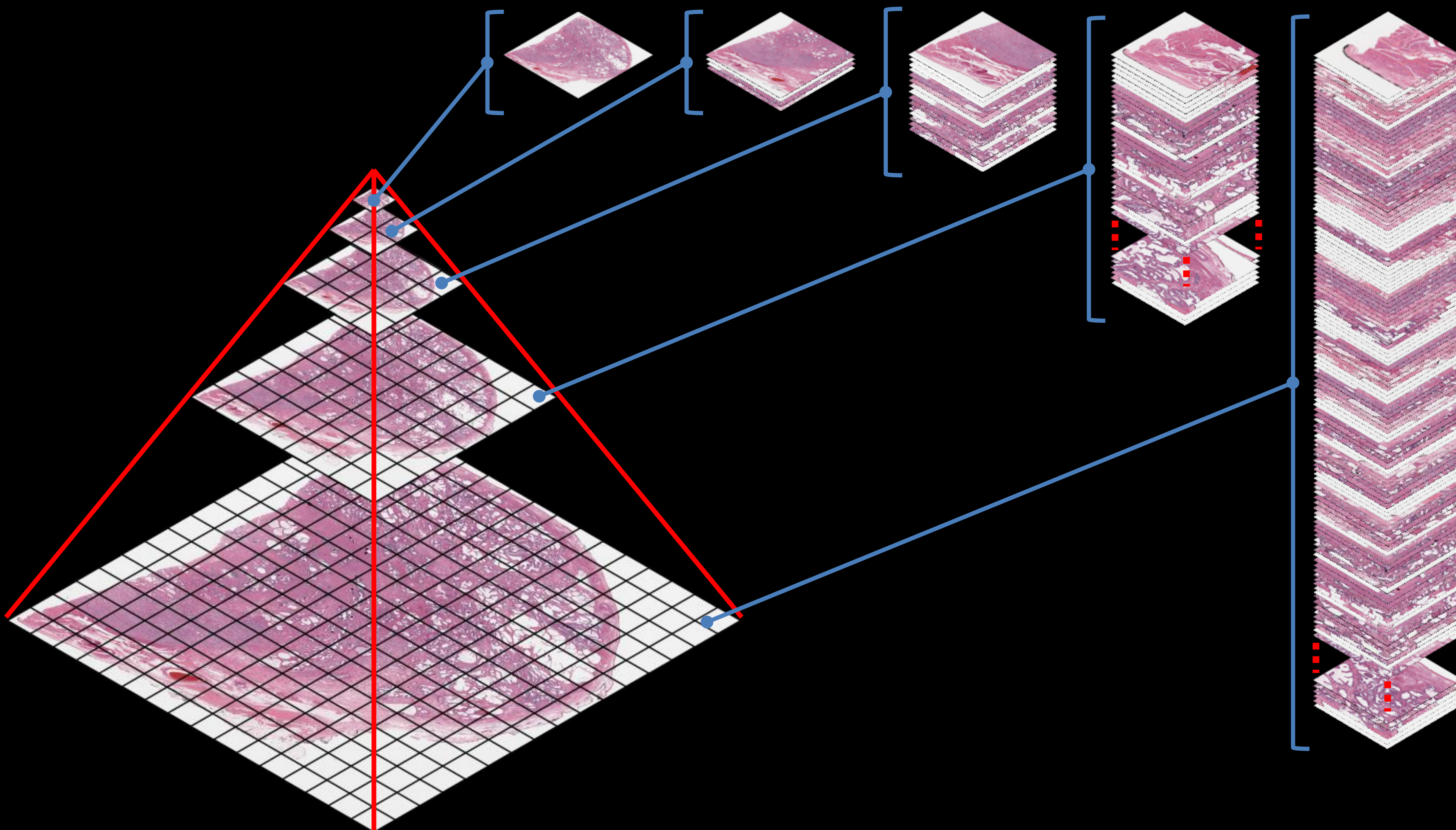
WSI file format, cont.

- Most WSI files contain an “image pyramid”
- Zoom levels are pre-calculated and stored in the file
- Each zoom level is further broken into small tiles (e.g. 256 x 256 px)
- The combination of the pyramid and tiling allows for efficient retrieval of image data for a given region at a specific magnification

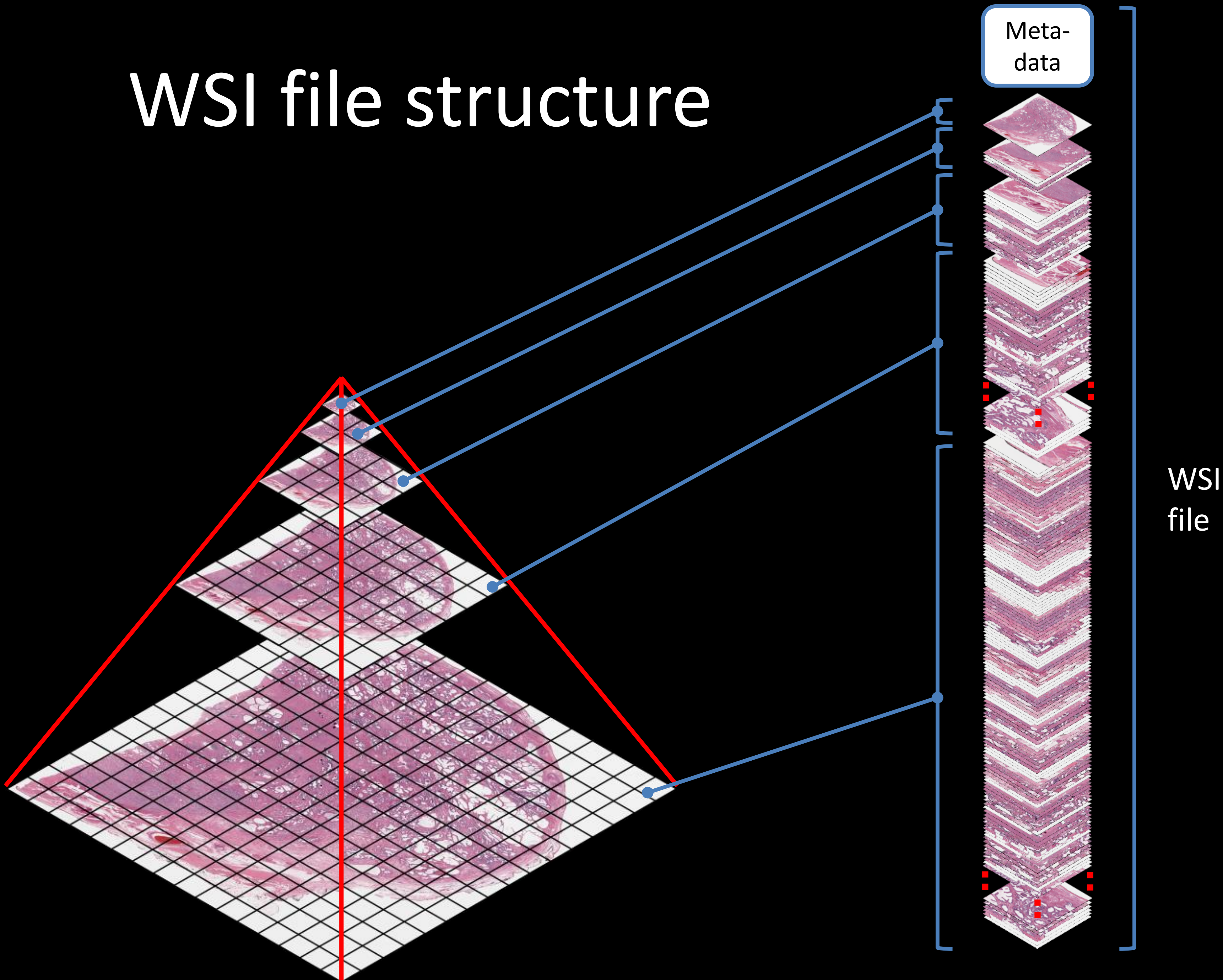
WSI file pyramid structure



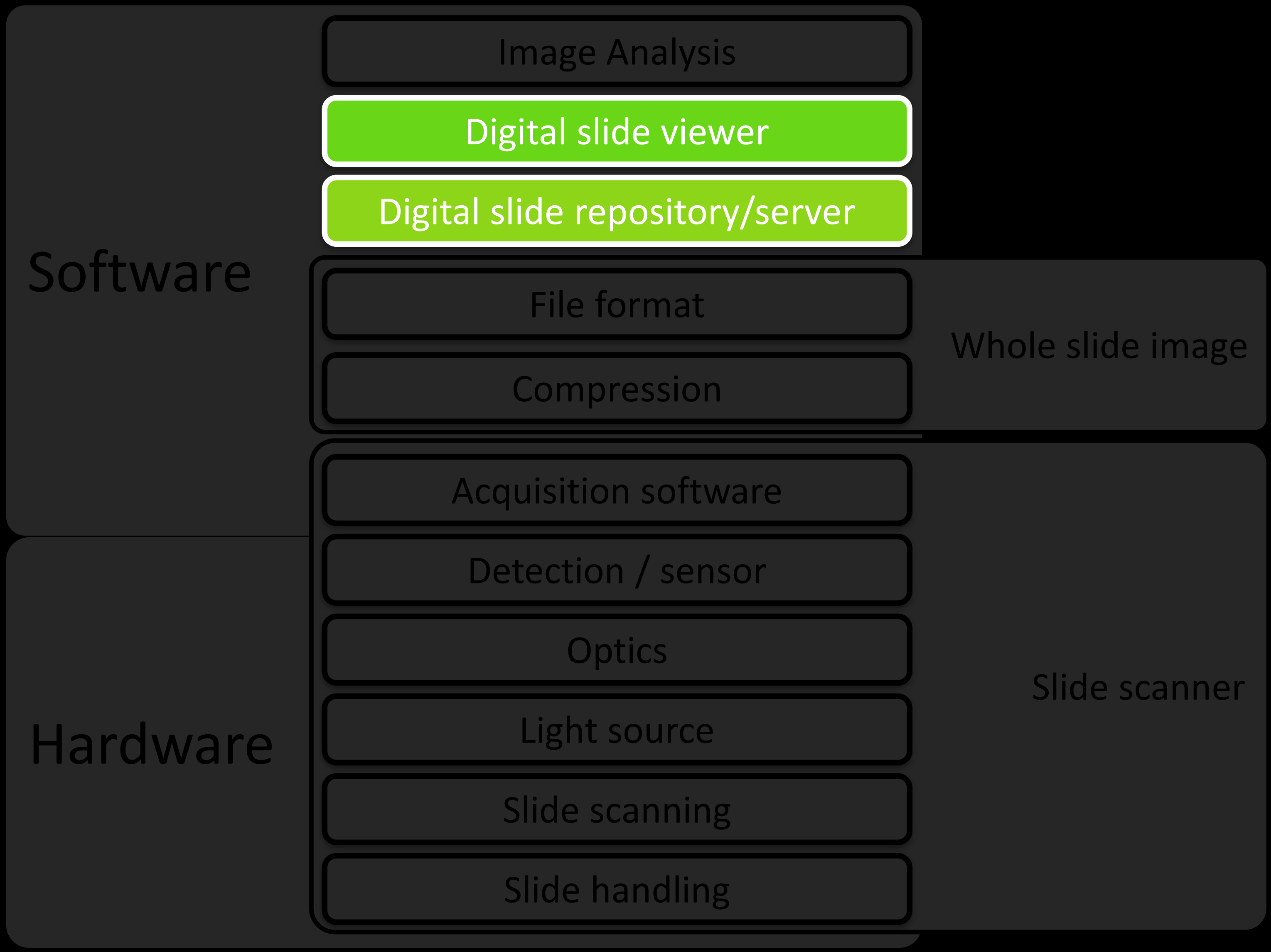
Each level is composed of tiles



WSI file structure



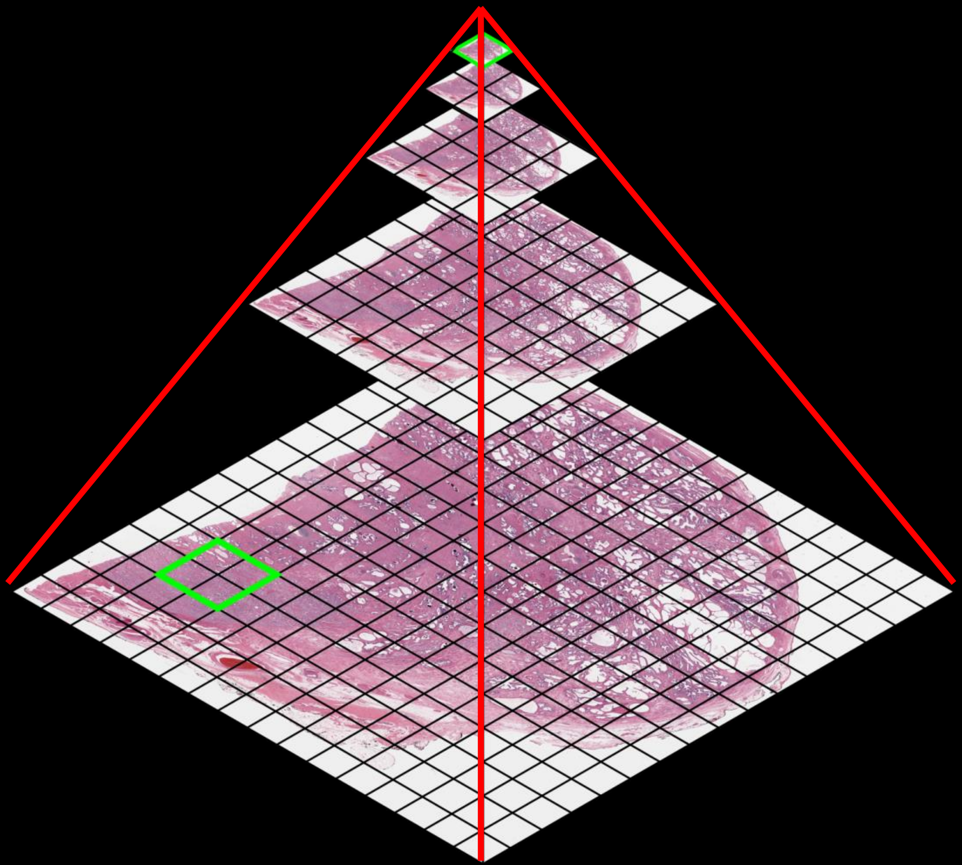
WSI: A layer model



Digital slide repository

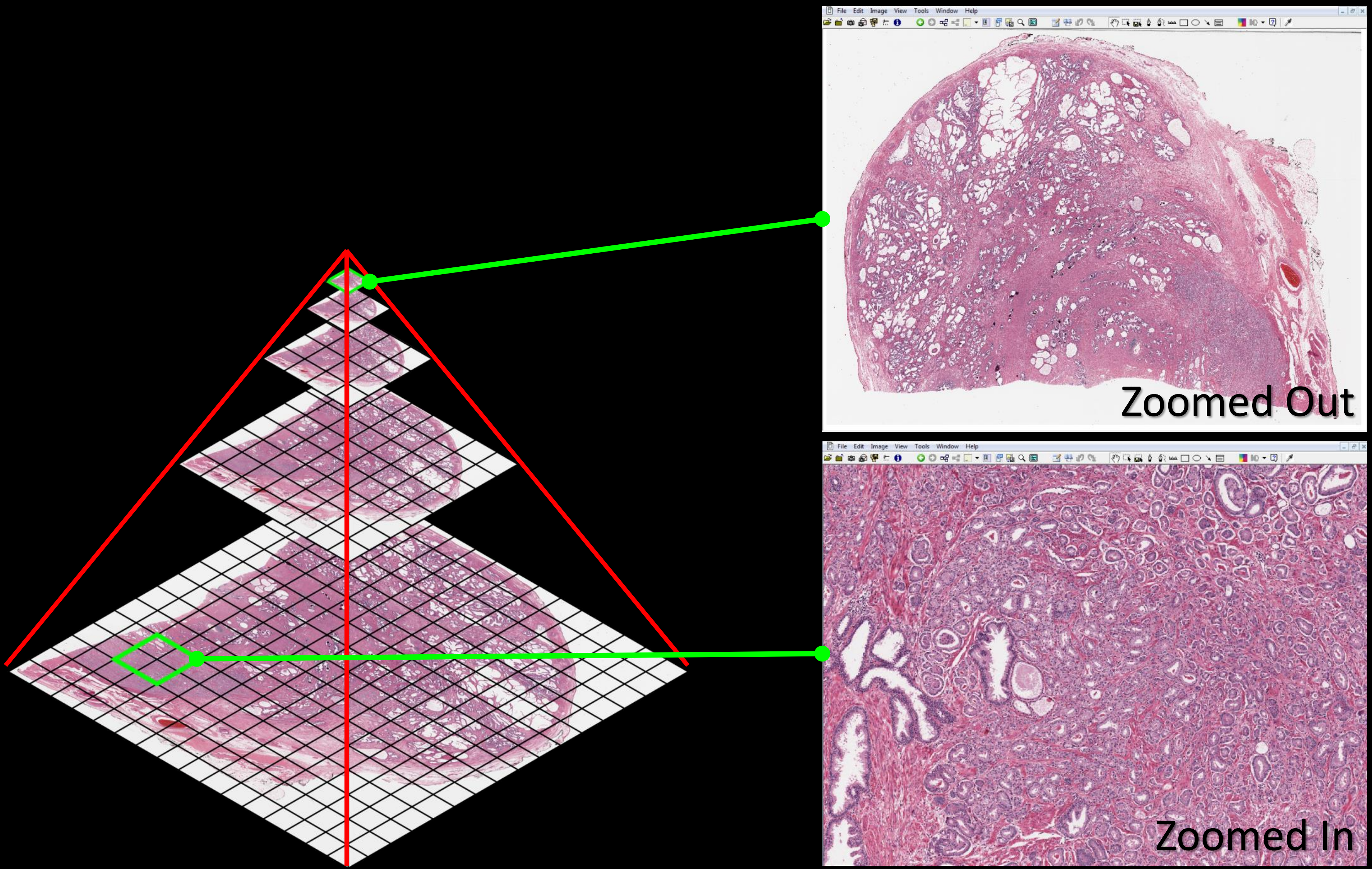
- The DSR stores image data and metadata
- The DSR serves image data to a viewer client
- Web client and/or thick client
- Many DSRs also support image analysis, interfaces to the LIS, etc.

Retrieving a view from a WSI



- A viewer client connects to the DSR
- The client requests the area of the image being displayed (green) at a particular zoom level
- The DSR then sends *only the tiles needed* to fulfill the request

Retrieving a view from a WSI



Digital slide repository, cont.

- Can the DSR use Active Directory / LDAP to authenticate users?
  - If yes, is it included in the price?
  - Will it actually work at your site?

- Will the DSR support other vendor file types?

- Will the DSR support your use case(s)?
  - Can always consider a third-party product

Key issues with WSI viewers

- Fat client: Operating system compatibility
  - Very few fat/native clients support OSX or Linux
- Web client: Browser compatibility
  - Beware web clients that rely on browser plugins!
    - Silverlight
    - Flash
    - Java
  - HTML5 web clients are the best option

Key issues with WSI viewers, cont.

- Does the client support Z-stack images?
- Does the client support other vendors’ file types?

WSI: A layer model

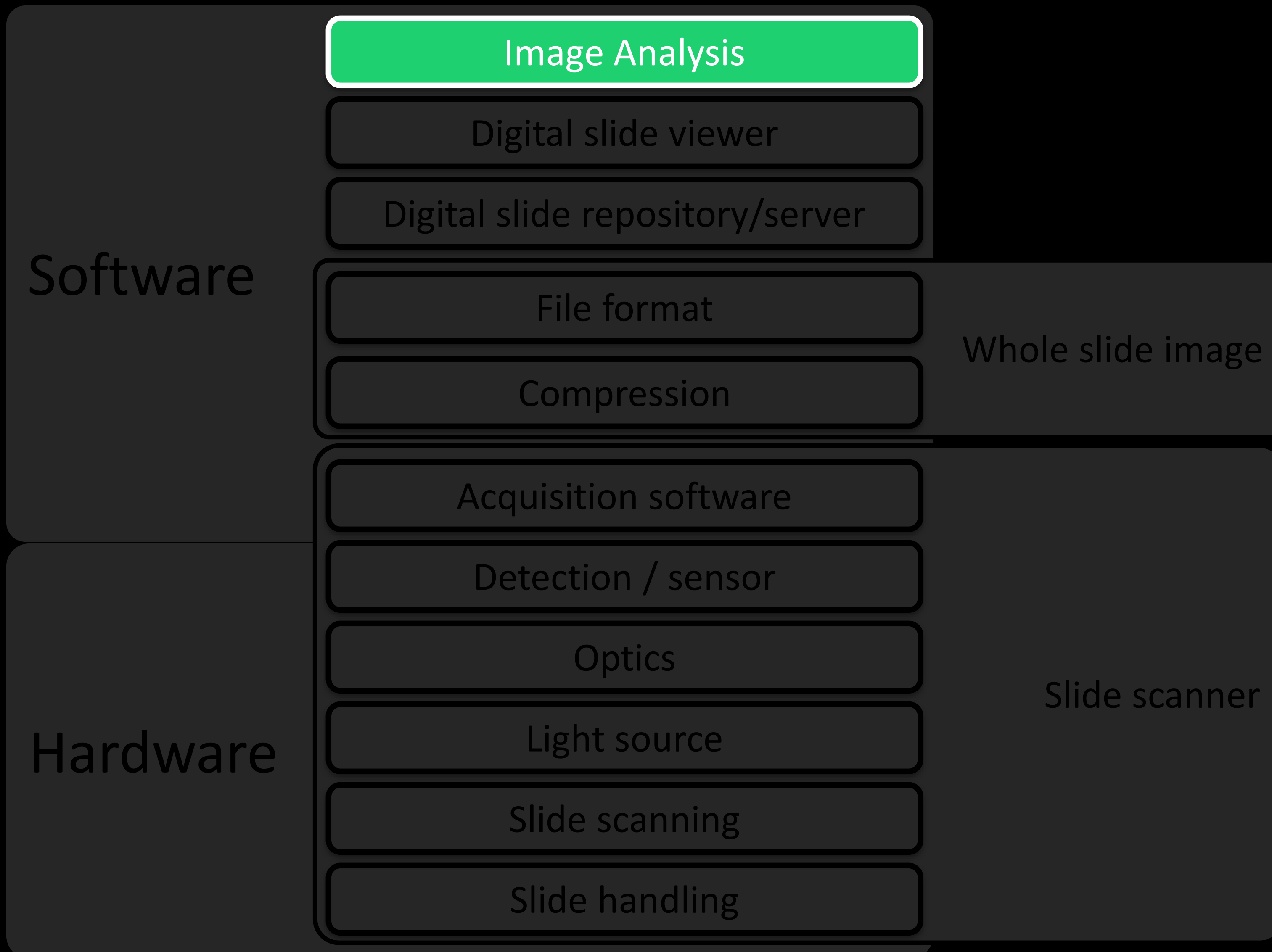


Image analysis

- Large topic beyond the scope of this talk

- Selected Platform Lectures
  - *Image Analysis for Routine Workflow*
  - Christopher Williams
  - Tuesday, May 24
  - 11:20 - 12:00 pm

Purchasing a system

Purchasing a system: gotchas

- Contact your LIS vendor prior to find out if/how you can interface (and $$$)
- Make sure your IT/Network/Security group vets <u>all</u> software prior to contracting
  - If issues found, get remediation in the contract
- Strongly consider adding penalties if the terms of the support contract are not met

Purchasing a system: gotchas, cont.

- Consider using your own server hardware if allowed
  - Vendors sometimes quote suboptimal hardware to keep the ticket price low
  - System needs to be robust with an obvious upgrade path to increase storage, etc.

Implementation

Implementation: installation

- Vendor should have a plan for actual installation of hardware and softwaref

- Needs to be coordinated with local IT and networking staff, including possible provisioning or activation of new networking infrastructure

- If PHI -> BEHIND THE FIREWALL!!!!

Implementation: Compliance

- CAP currently has multiple LAP Checklist items covering:
  - Telepathology (Lab General)
  - Whole Slide Imaging (Lab General)
  - Digital Image Analysis (Anatomic Pathology)

COLLEGE of AMERICAN PATHOLOGISTS

WHOLE SLIDE IMAGING

This section applies to laboratories using whole slide imaging systems for diagnostic purposes (primary and/or consultation).

Inspector Instructions:

READ	• Sampling of training records • System validation records

*****NEW** 04/21/2014***

GEN.52900 Whole Slide Imaging User Training **Phase I**

There are records showing that all users of the whole slide imaging system have been trained.

NOTE: Users of the whole slide imaging system include individuals responsible for slide scanning and digital slide quality assessment, as well as pathologists.

Evidence of Compliance:

✓ Records for training on the use of the whole slide imaging system for diagnostic purposes

Implementation: training

- Initial training is usually done by vendor
- Your organization needs to develop its own policies and procedures for training staff

Implementation: training, cont.

- All staff that are involved in some aspect of digital pathology need to be trained
  - Training needs to tailored to their role
  - Training needs to be meaningful
  - Training needs to be documented

***NEW** 04/21/2014*

GEN.52920 Whole Slide Imaging System Validation **Phase I**

The laboratory validates whole slide imaging systems used for clinical diagnostic purposes by performing its own validation studies, including approval for use by the laboratory director (or designee who meets CAP director qualifications) before the technology is used for the intended diagnostic purpose(s).

NOTE: The specific components of the validation study are left to the discretion of the laboratory.

As general guiding principles, the validation process should:

- *Closely emulate the real-world clinical environment and involve specimen preparation types and clinical settings relevant to the intended use(s);*
- *Be carried out by a pathologist(s) adequately trained to use the system;*
- *Assess intraobserver concordance between digital and glass slides;*
- *Encompass the entire whole slide imaging system, with reevaluation if a significant change is made to a previously validated system.*

Evidence of Compliance:

✓ Records of completed validation study with review and approval

REFERENCES

1) Pantanowitz *et al*, Validating whole slide imaging for diagnostic purposes in pathology: Guideline from the College of American Pathologists Pathology and Laboratory Quality Center. *ARPA*, 2013
http://www.archivesofpathology.org/doi/pdf/10.5858/arpa.2013-0093-CP
http://www.cap.org/apps/docs/membership/wsi_faqs.pdf
2) Validation of Digital Pathology in Healthcare Environment: A Whitepaper from the Digital Pathology Association, 2011
http://digitalpathologyassociation.org/_data/files/DPA-Healthcare-White-Paper--FINAL_v1.0.pdf

Validation: guidelines

- Pantanowitz, et al. Validating WSI for diagnostic Purposes in Pathology, *Arch Pathol Lab Med* 2013.

- Chose 23 validation studies (out of the 767) for review by a methodologist

- Arrived at twelve validation guidelines – graded these A, B or Expert Consensus (EC)

Validation: guidelines, cont.

	Recommendations	Grade
1	All labs should carry out their own validation	EC
2	Validation should be appropriate for, and applicable to, the intended clinical use and clinical setting in which WSI will be employed	A
3	The validation study should closely emulate the real-world clinical environment in which the technology will be used	A
4	The validation study should encompass the entire WSI system	B
5	Revalidation is required whenever a significant change is made to any component of the WSI system	EC
6	Pathologist(s) adequately trained to use the WSI system must be involved in the validation process	B
7	The validation process should include a sample set of at least 60 cases for one application that reflects the spectrum and complexity of specimen types and diagnoses likely to be encountered during routine practice	A

Validation: guidelines, cont.

	Recommendations	Grade
8	The validation study should establish diagnostic concordance between digital and glass slides for the same observer (i.e. intraobserver variability)	A
9	Digital and glass slides can be evaluated in random or nonrandom order (as to which is examined first and second) during the validation process.	A
10	A washout period of at least 2 weeks should occur between viewing digital and glass slides	B
11	The validation process should confirm that all of the material present on a glass slide to be scanned is included in the digital image	EC
12	Documentation should be maintained recording the method, measurements, and final approval of validation for the WSI system to be used in the clinical laboratory	EC

System validation

- For more details, I recommend:

- *Validating a Whole Slide Imaging System - A Case Based Approach to the CAP Guidelines*
    - Brent Tan
    - Applied Anatomical and Clinical Informatics
    - Tuesday, May 24
    - 9:00 - 9:35 am

Implementation: add’l policies

- Develop policies and/or procedures for:
  - User/data access
  - System downtime
  - Disaster recovery

Implementation example

- DPA Companion Session
  - *Implementing digital pathology at a large academic medical center: the nuts and bolts*
    - Liron Pantanowitz
    - Monday, May 23
    - 6:30 - 7:00 pm

Post-implementation

Post-implementation

- Keep up with required maintenance of software and hardware
- Chart any regular calibration steps required for your instrument
- Monitor the performance of the digital pathology system to ensure quality

Post-implementation, cont.

- Continue to train and document training of new users

- If the system changes or new use cases are introduced
  - Revalidate the system
  - Provide additional or updated training to staff

Post-implementation, cont.

- Monitor storage space
  - If you fill 80% of your storage, you need to have a plan to expand storage or free storage

Related sessions

- Pantanowitz: *Implementing digital pathology at a large academic medical center: the nuts and bolts*
  – Monday, May 23: 6:30 - 7:00 pm

- Tan: *Validating a Whole Slide Imaging System - A Case Based Approach to the CAP Guidelines*
  - Tuesday, May 24:   9:00 - 9:35 am

- Williams: *Image Analysis for Routine Workflow*
  – Tuesday, May 24: 11:20 - 12:00 pm