DICOM in Pathology as a Standard

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 re-DICOM

Interoperability

“the ability of two or more systems or components to exchange information and to use the information that has been exchanged”

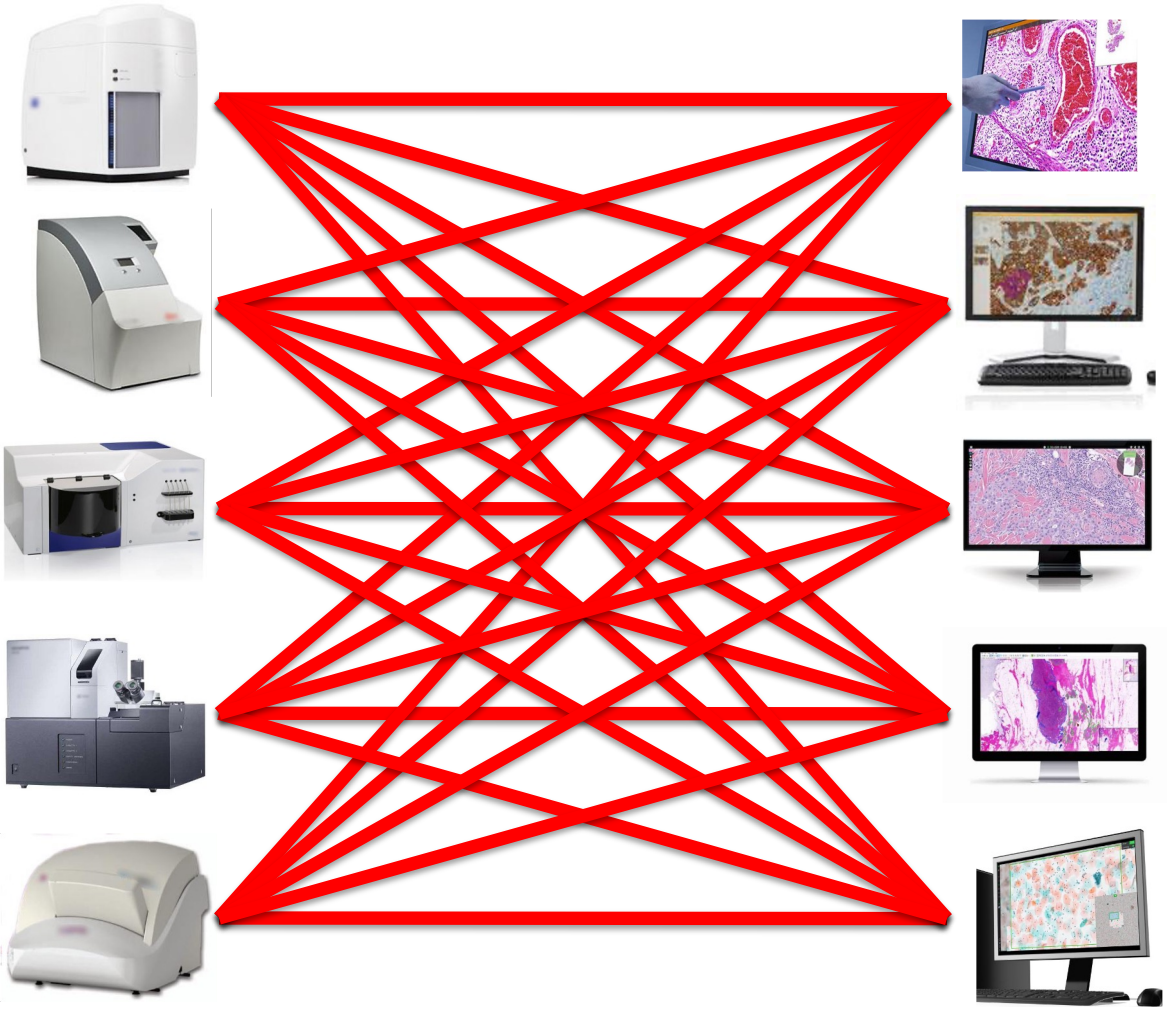
IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries. 1990

JOHN PALFREY AND URS GASSER

Interop

The **PROMISE** *and* **PERILS** *of*

HIGHLY INTERCONNECTED SYSTEMS



Interoperability

via standards

Standard

images

annotations

protocols

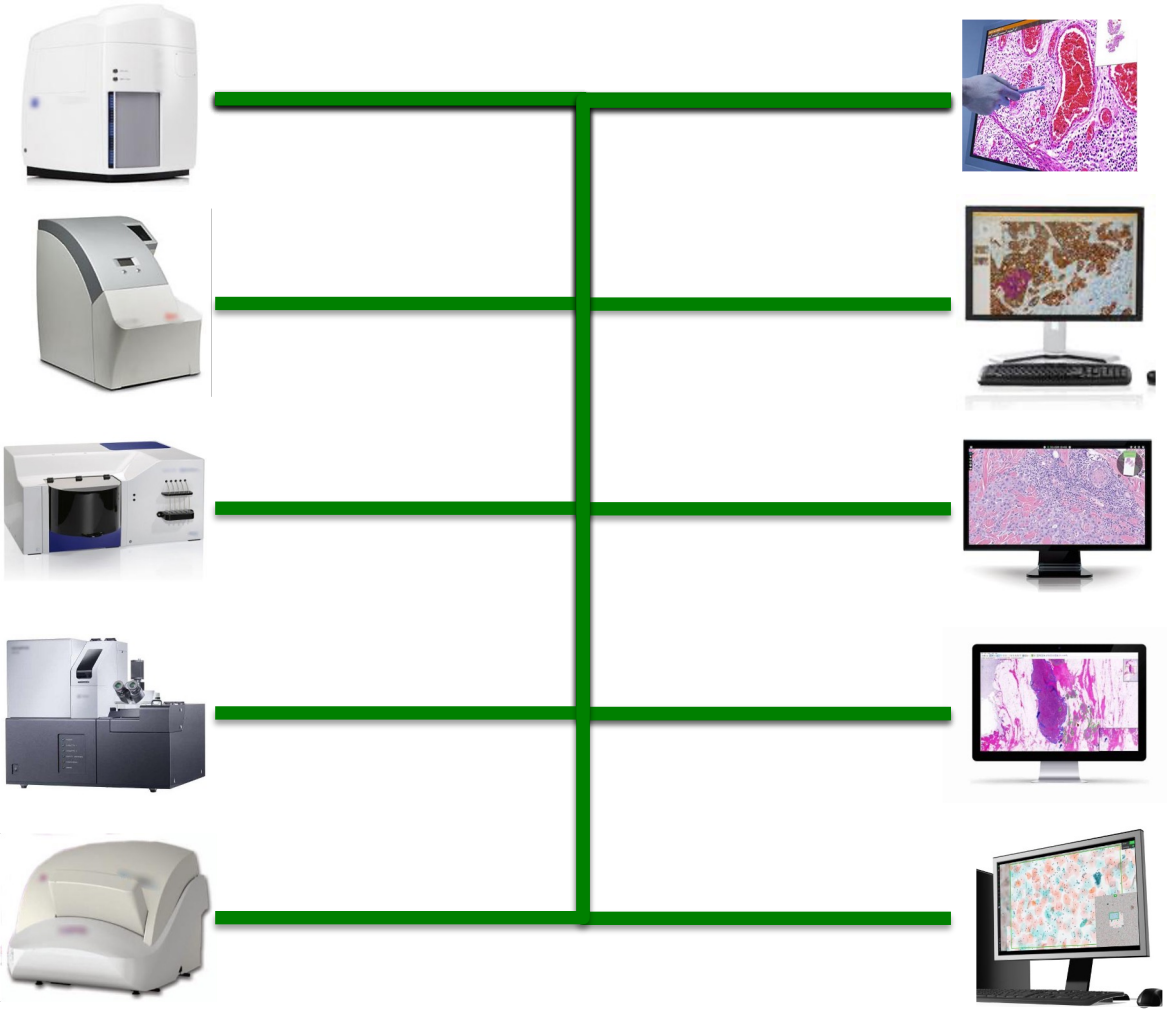
Separation

scanner

archive

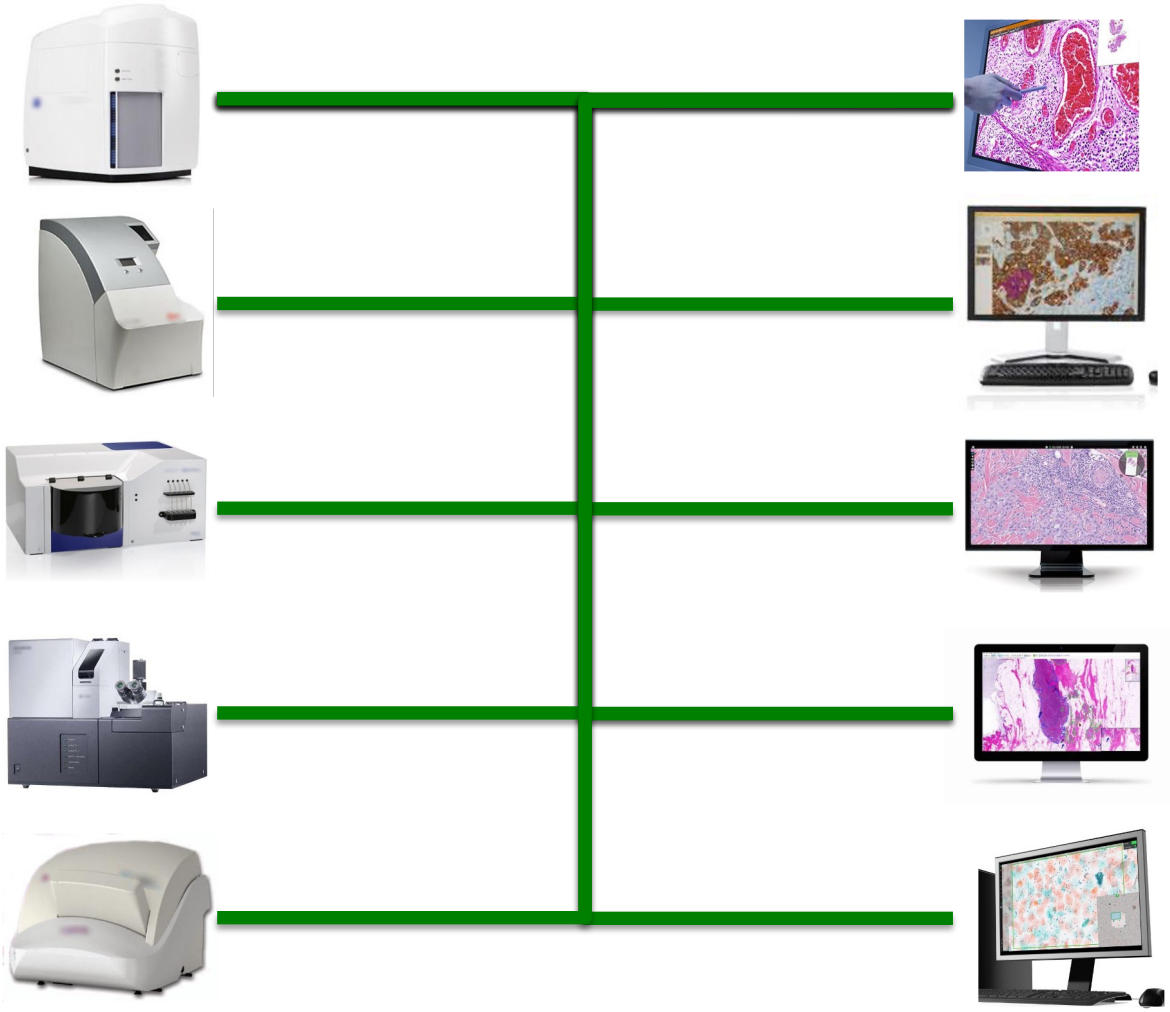
viewer

analyzer



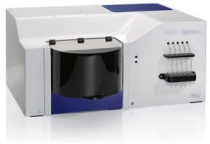
Which standard?

Can there be only one?



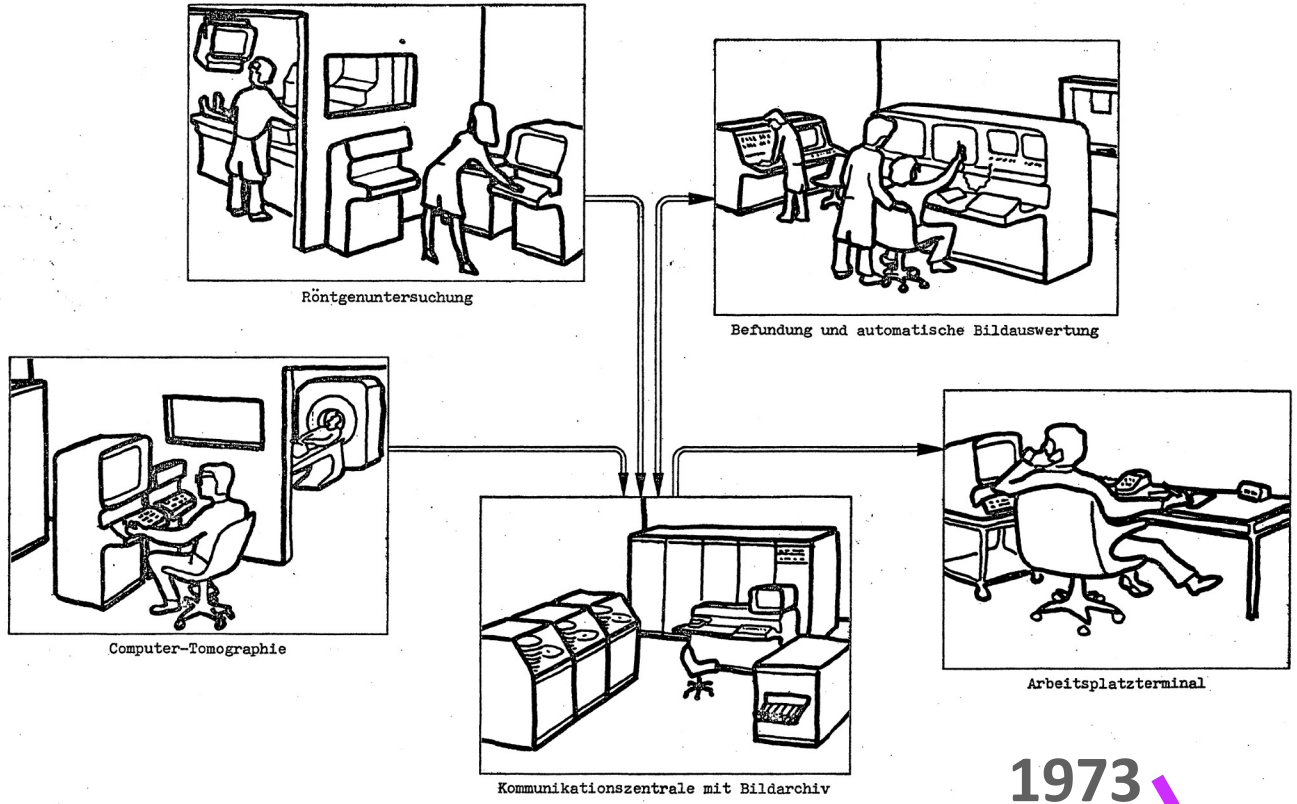
DICOM℠

Digital Imaging and Communications in Medicine



Why DICOM?

- It's everywhere
  - esp. radiology, cardiology, radiotherapy
  - increasingly visible light and related 'ologies (enterprise)
  - less pathology (yet), historical use of proprietary formats
- It’s
  - open to access and use
  - has lots of free open source tools that support it
  - supported and maintained (38 years since 1985 release)
  - recognized by ISO (12052) and regulators (FDA)
- It has all the metadata
  - identifying and descriptive
  - patient (subject, case), study, series, image, acquisition, …



1973

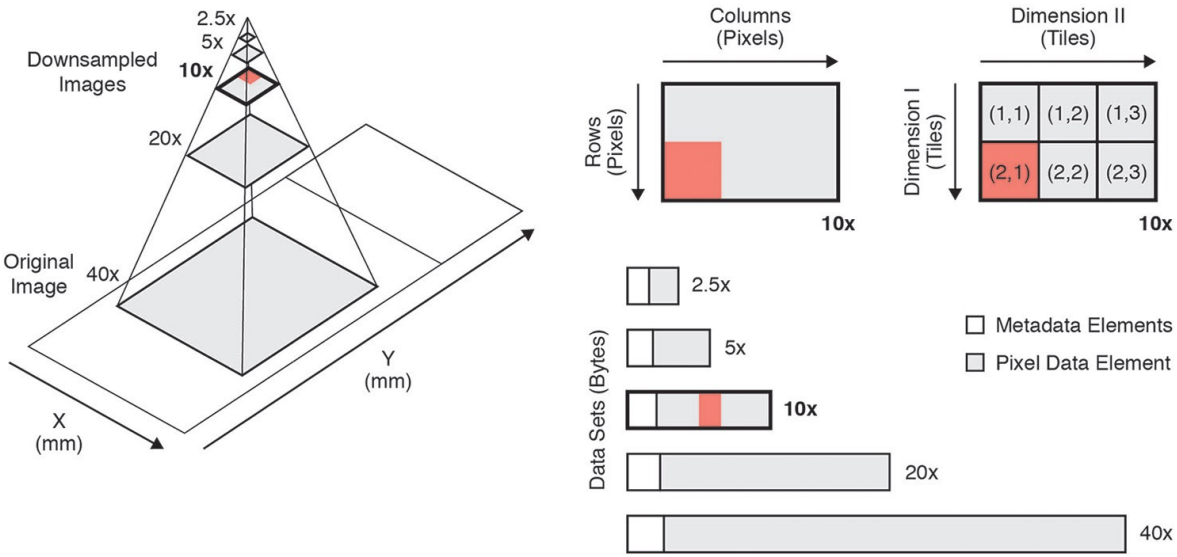
Meyer-Ebrecht D. [Electronic Archival System for X-Rays Images - Work proposal for a research project in the years 1974 and 1975] Elektronisches Archivierungssystem für Röntgenbilder – Arbeitsvorschlag für ein Forschungsprojekt in den Jahren 1974 und 1975. Hamburg, Germany: Philips Research Labs; 1973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

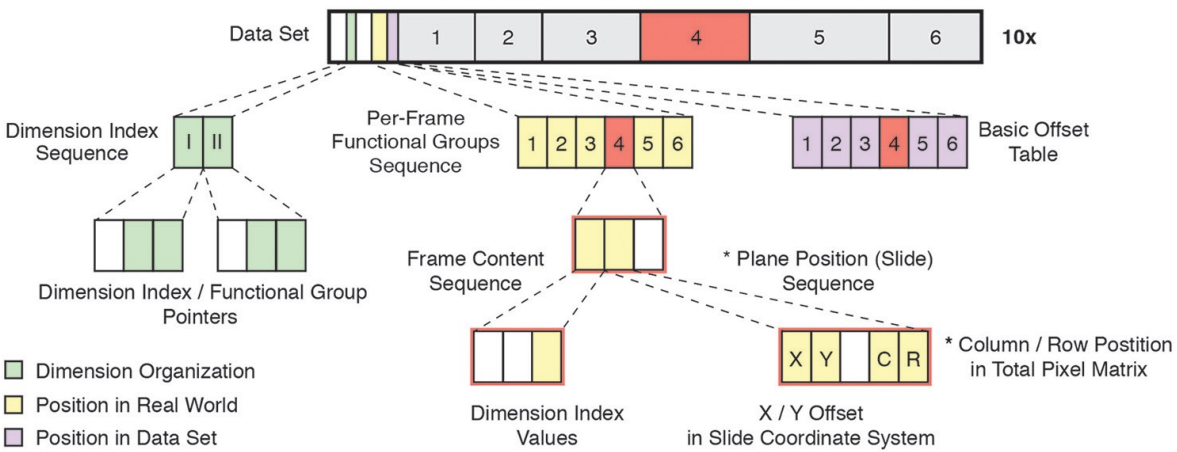
DICOM for Clinical Use vs. Research Use

- Clinical use
  - regulated off-the-shelf commercial medical devices
  - expect an automated solution out of the box (plug-and-play)
  - expect to select best of breed (vendor interoperability)
  - leverage hospital/clinic IT infrastructure (archive, security, …)
  - everything else (imaging) is already DICOM-based
- Research use (academic, commercial)
  - less regulated, more flexible, innovative (cutting/bleeding edge)
  - less centralized infrastructure and support (changing w. cloud)
  - can still leverage standard solutions, esp. w. open source
  - historic vendor-proprietary monolithic solutions, don’t have to be
  - relies less on data management (out-of-band metadata, CSV files)

Interoperability boundaries for pathology imaging

- Access to input data
  - images ✓ *DICOM WSMI (tiled pyramids)*
  - annotations ✓ *DICOM SEG, SR, ANN*
  - protocols ~ *DICOMweb query, metadata, frames*
- Sharing of output data
  - images ✓ *DICOM parametric maps (tiled pyramids)*
  - annotations ✓ *DICOM SEG, SR, ANN*
  - protocols ~ *DICOMweb STOW*
- Management of workflow
  - application selection ✗
  - application orchestration ~ *DICOMweb UPS*

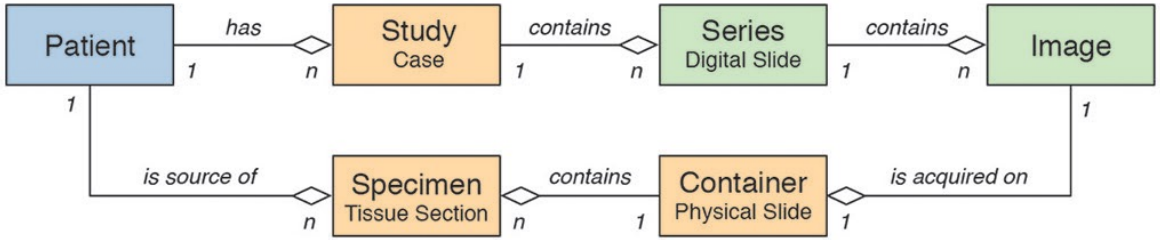




[Herrmann 2018]

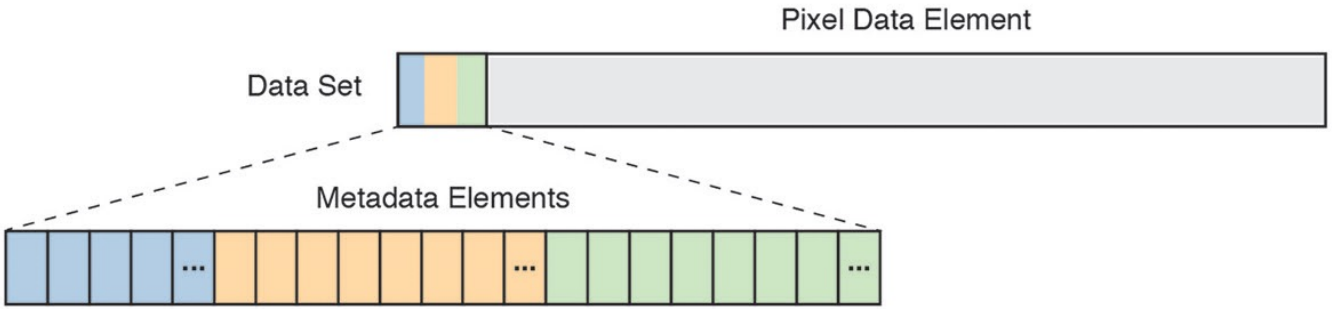
It’s the metadata, stupid

http://medium.com/digital-trends-index/its-the-metadata-stupid-12a4fc121e45#.4zhwdz5y0

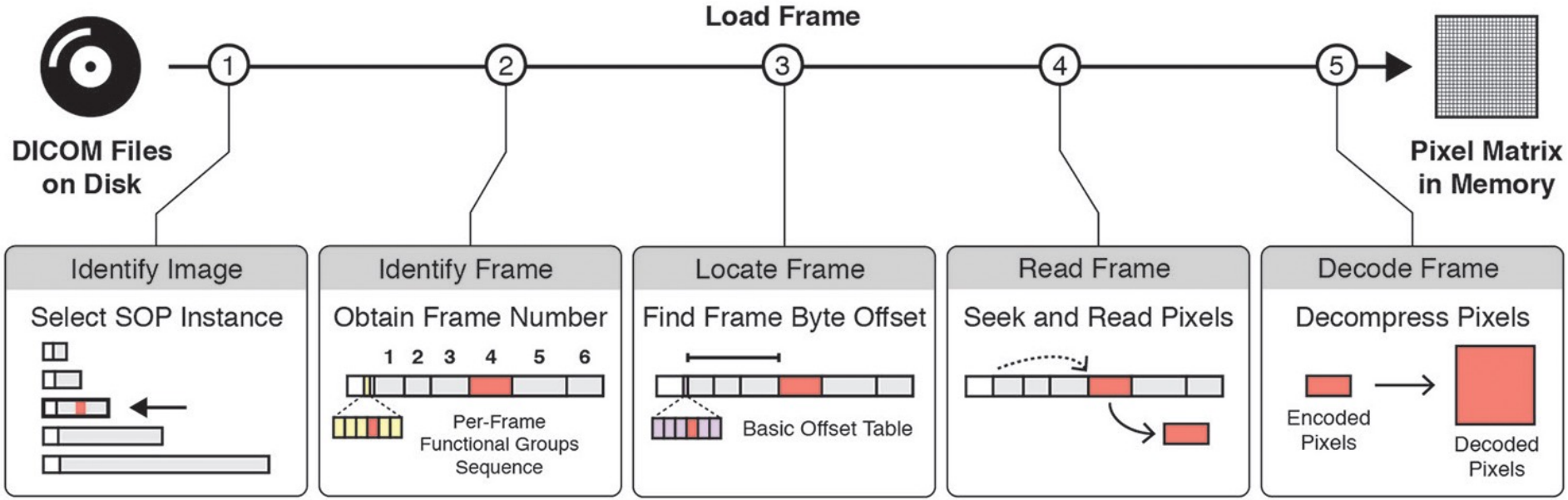


VL Whole Slide Microscopy Image

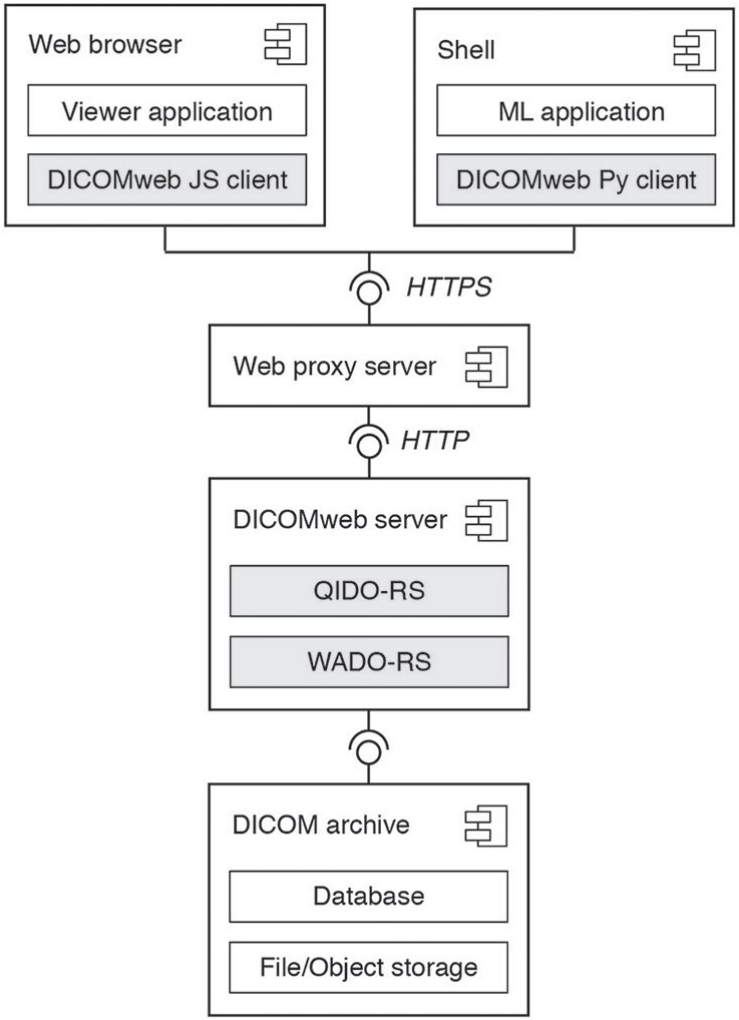
Patient	General Study	General Series	Specimen	...	General Image	Image Pixel
Patient's Name	Study Instance UID	Series Instance UID	Container Identifier		Instance Number	Samples Per Pixel
Patient's Sex	Study Date	Series Date	Container Description		Acquisition Date	Rows
Patient's Birth Date	Study Time	Series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

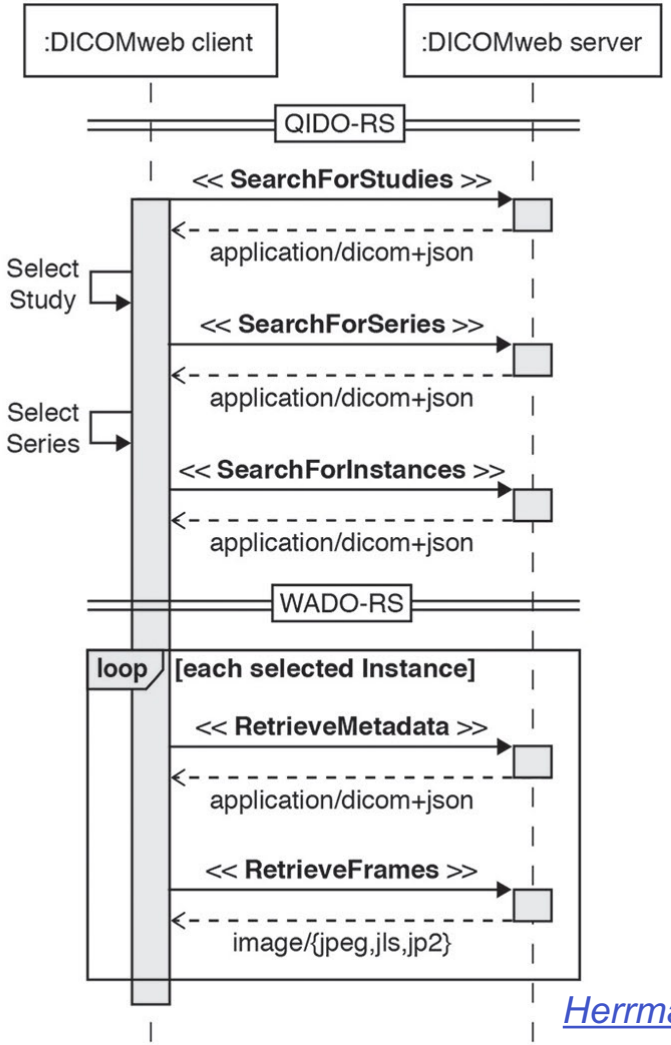


[Herrmann 2018]



Herrmann 2018





Herrmann 2018

Why not TIFF?

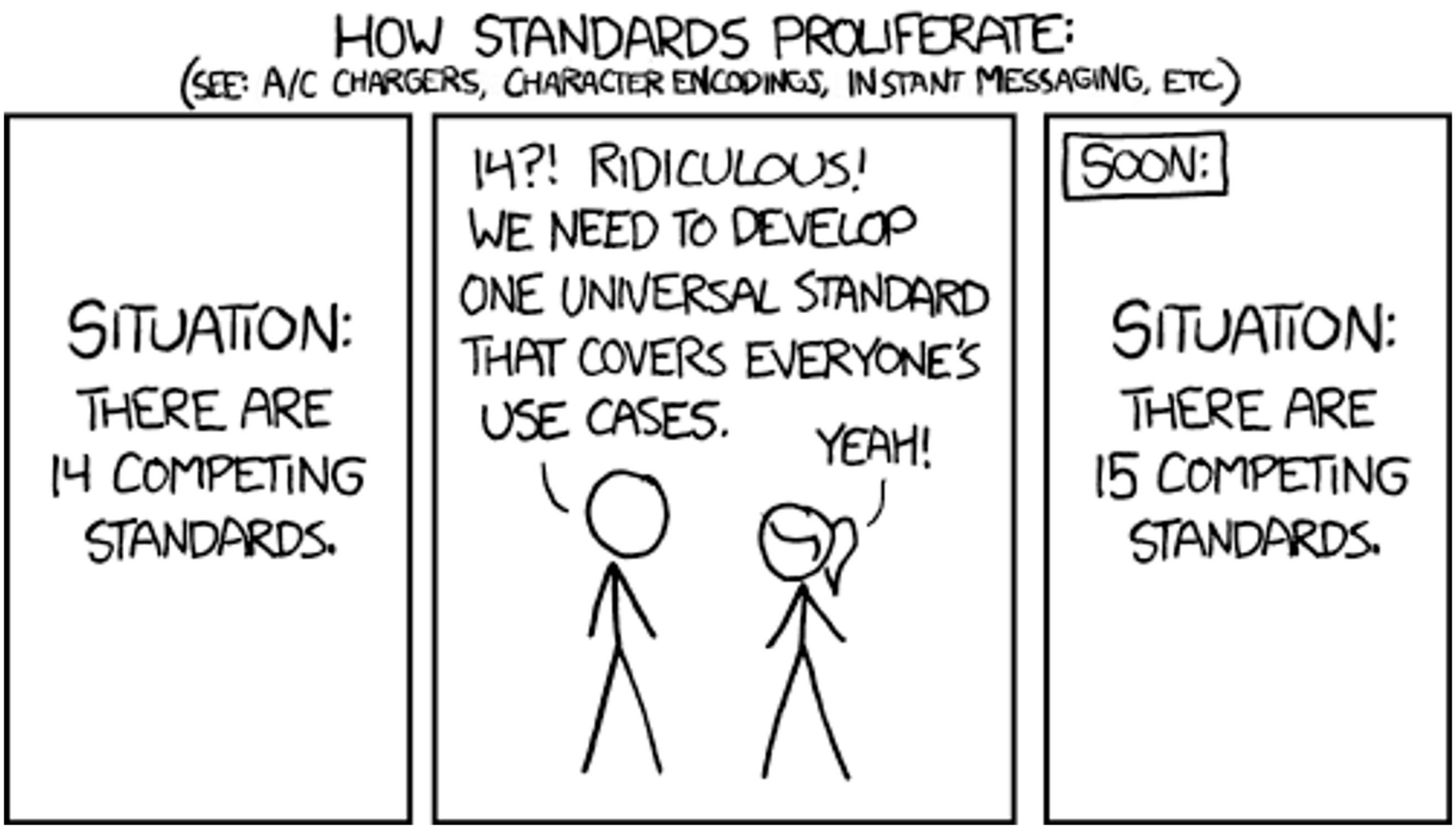
TIFF is a fine format, popular among researchers, open source tools
The basis of many WSI scanner vendors' proprietary formats
Even has limited standardization of metadata possibilities (OME-XML)
Too many vendor variants wrt. metadata (often absent, incomplete)

It's just not what the commercial clinical medical imaging world uses
DICOM is very TIFF-like wrt. tiled pyramid WSI pixel data encoding
Easy to transcode (losslessly) between DICOM WSI and TIFF
Commercial and open source converters available
Increasingly WSI scanner vendors are offering DICOM natively
Need for TIFF reduced by DICOM support in OpenSlide, BioFormats
Can use dual-personality DICOM-TIFF (e.g., as in IDC)

Bottom line …

Digital pathology not really as different or special as claimed
Use the same standard everyone else uses
Incrementally extend the standard prn
Layer application-specific functionality on standard mechanisms
Leverage enterprise archive (storage and business continuity)
Leverage enterprise security mechanisms

Use DICOM, improve DICOM
Don't take no for an answer from scanner and other vendors
Don’t allow vendors to demand more for a DICOM license



http://xkcd.com/927/

DICOM℠

Digital Imaging and Communications in Medicine