DICOM

Dermatology

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Pixelmed Publishing, LLC.

Background & Disclosures

- Owner, PixelMed Publishing, LLC
- Radiologist

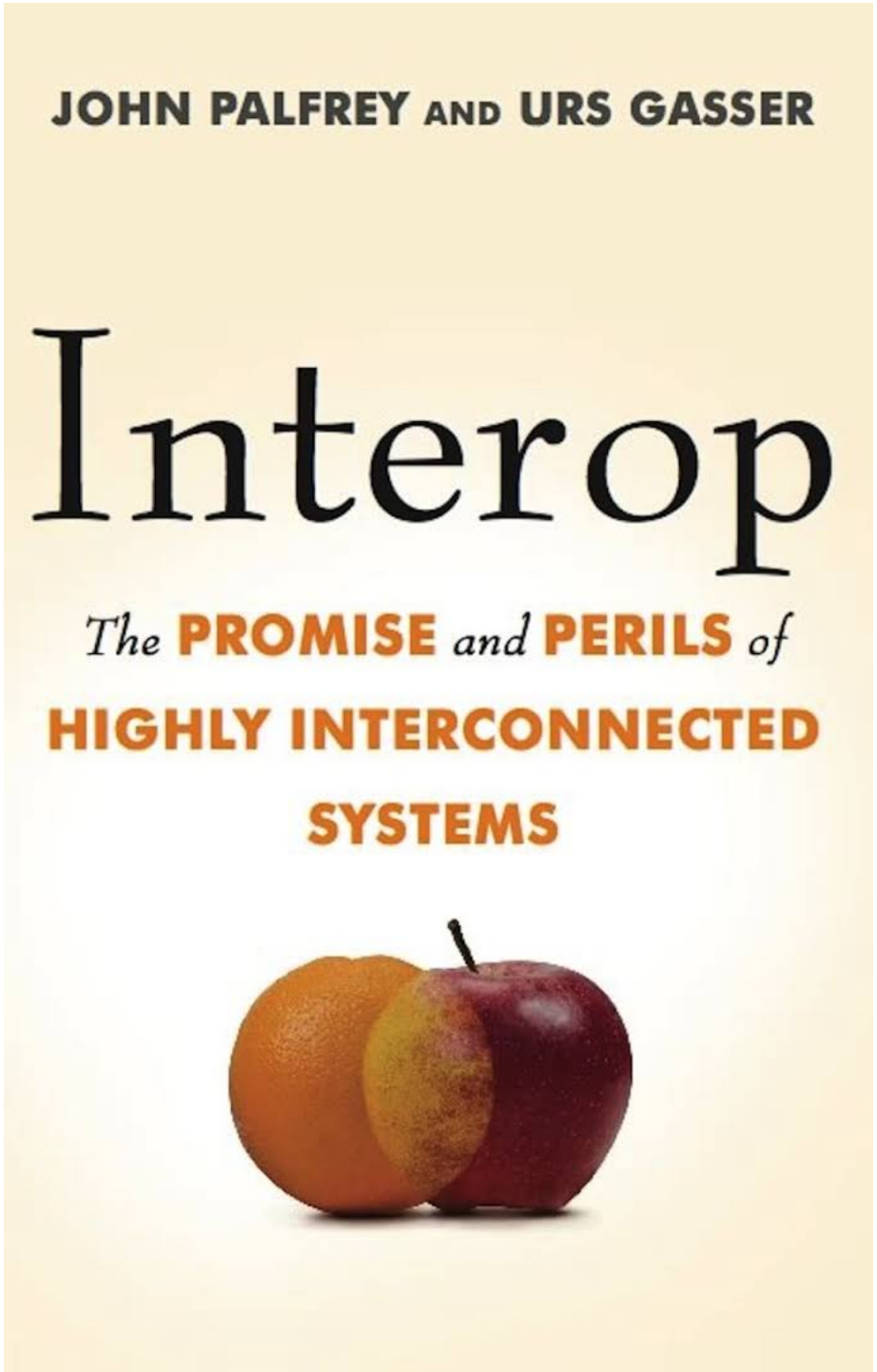
- Independent Consultant – GE, Carestream, Curemetrix, MDDX, Pathcore

- Editor of DICOM Standard (NEMA contract)
- Formerly co-chair DICOM Standards Committee
- Formerly co-chair IHE Radiology Technical Committee

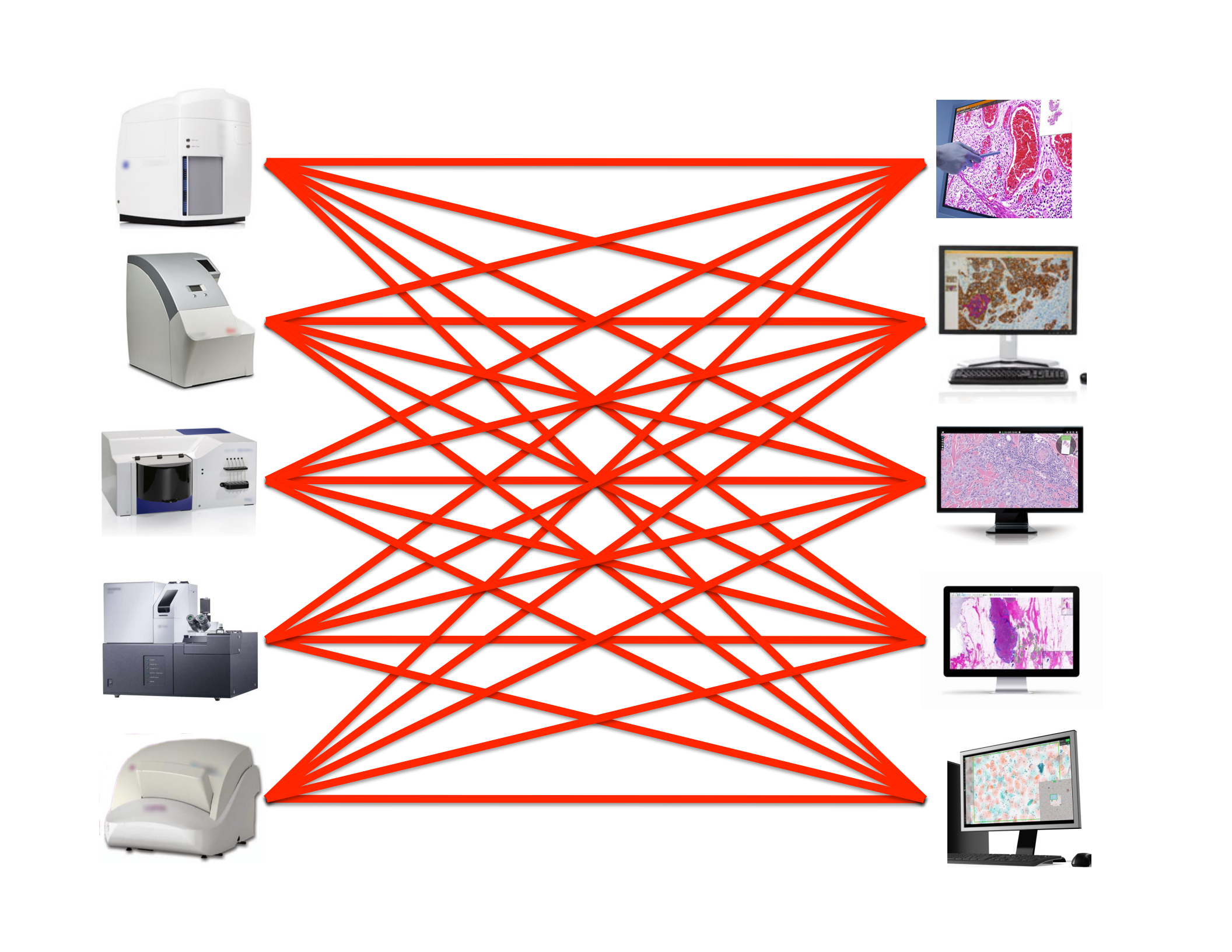
Interoperability

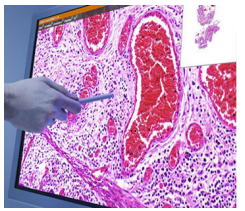
*"the ability of two or more systems or components to **exchange** information and to **use** the information that has been exchanged"*

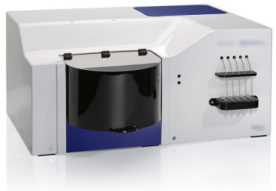
IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries. 1990

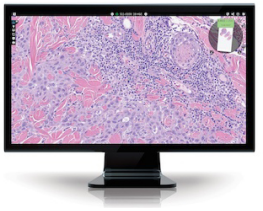


- *layers: technology, data, human, institutional*
- *consumer empowerment*
- *privacy, security*
- *competition, homogeneity, innovation*
- *efficiencies, complexity*
- *by design*
- *over time*
- *architectures*









Photoelectronic radiology department

M. Paul Capp, Sol Nudelman, Donald Fisher, Theron W. Ovitt, Gerald D. Pond,
Meryl M. Frost, Hans Roehrig, Joachim Seeger, Donald Oimette
Department of Radiology, University of Arizona Health Sciences Center, Tucson, Arizona 85724

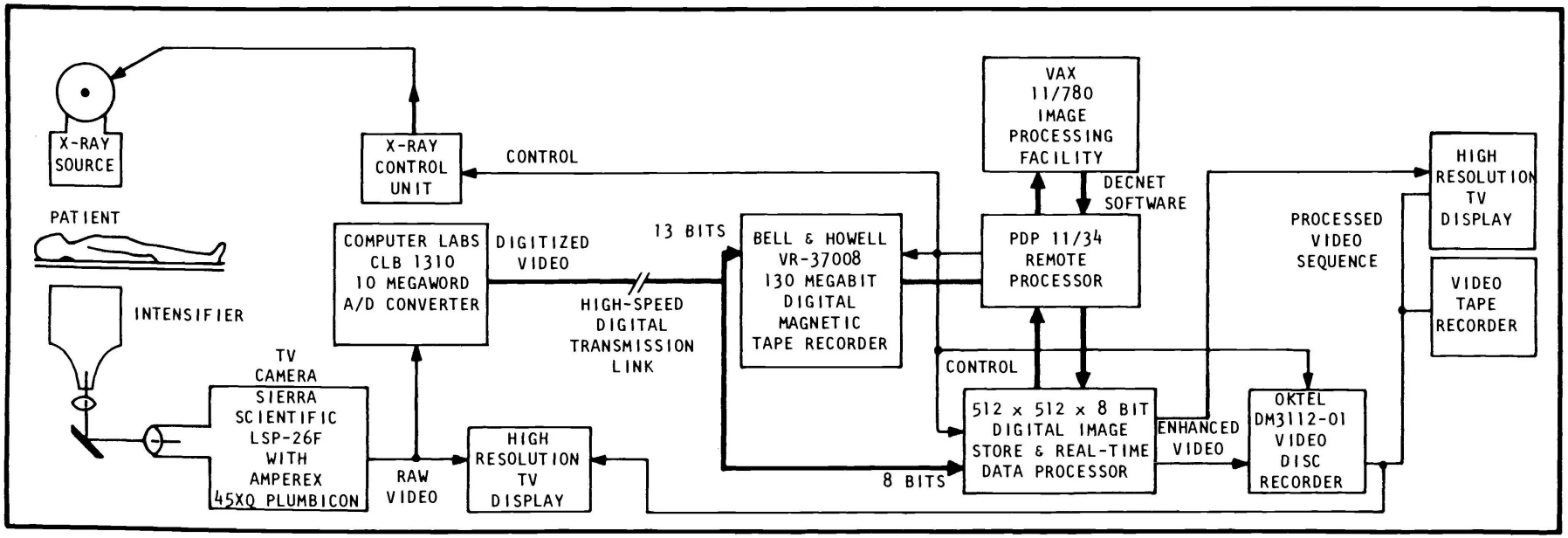
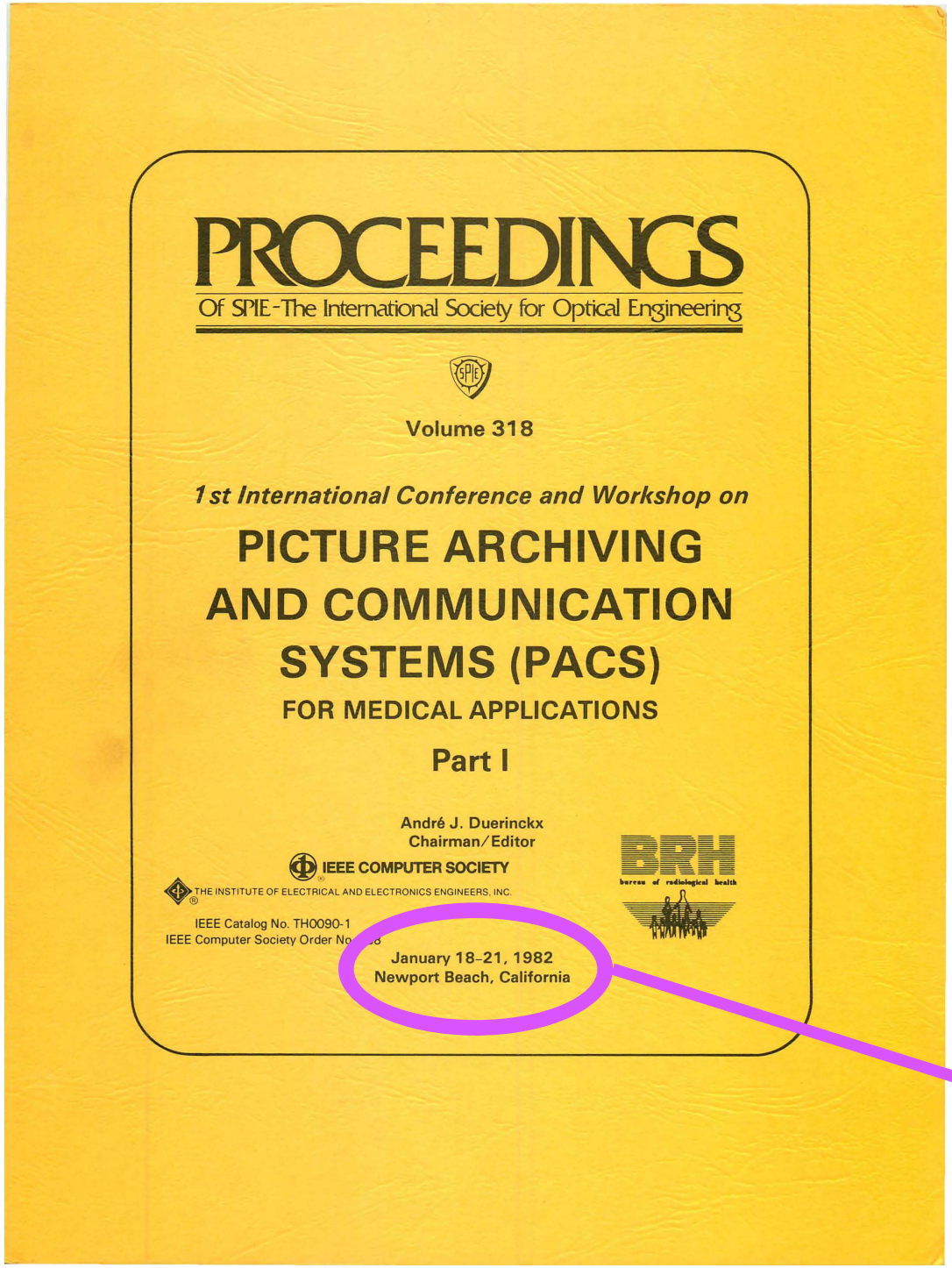


Figure 1. System block diagram of demonstration facility.

1981


PROCEEDINGS
Of SPIE-The International Society for Optical Engineering
Volume 318
1st International Conference and Workshop on
PICTURE ARCHIVING AND COMMUNICATION SYSTEMS (PACS)
FOR MEDICAL APPLICATIONS
Part I
André J. Duerinckx
Chairman/Editor
IEEE COMPUTER SOCIETY
THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.
IEEE Catalog No. TH0090-1
IEEE Computer Society Order No
January 18-21, 1982
Newport Beach, California
BRH
bureau of radiological health
1982

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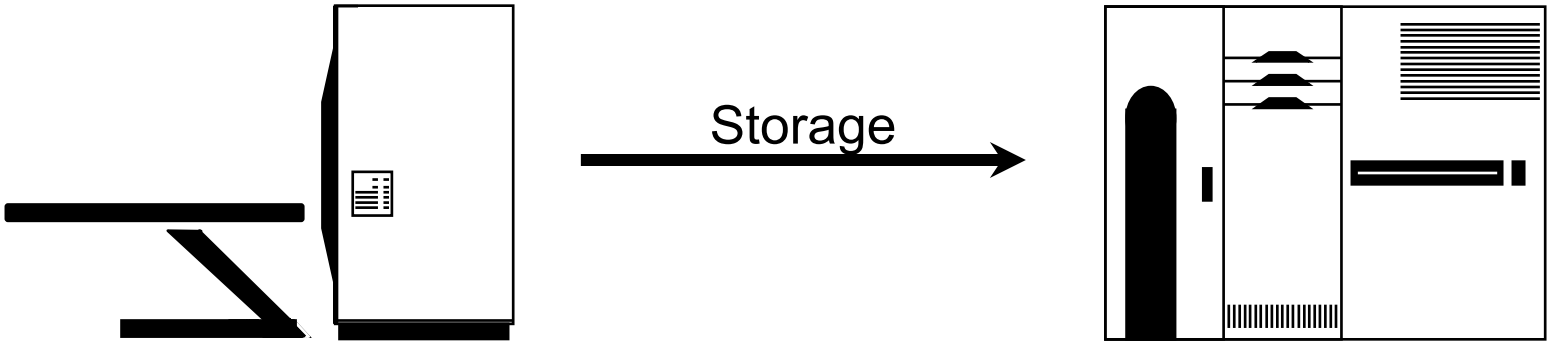
Th. Wendler, D. Meyer-Ebrecht, James M. Jemiola, Philips Research Center, Hamburg, FRG

32 years ago – radiology PACS and DICOM ubiquitous 15-20 years later!

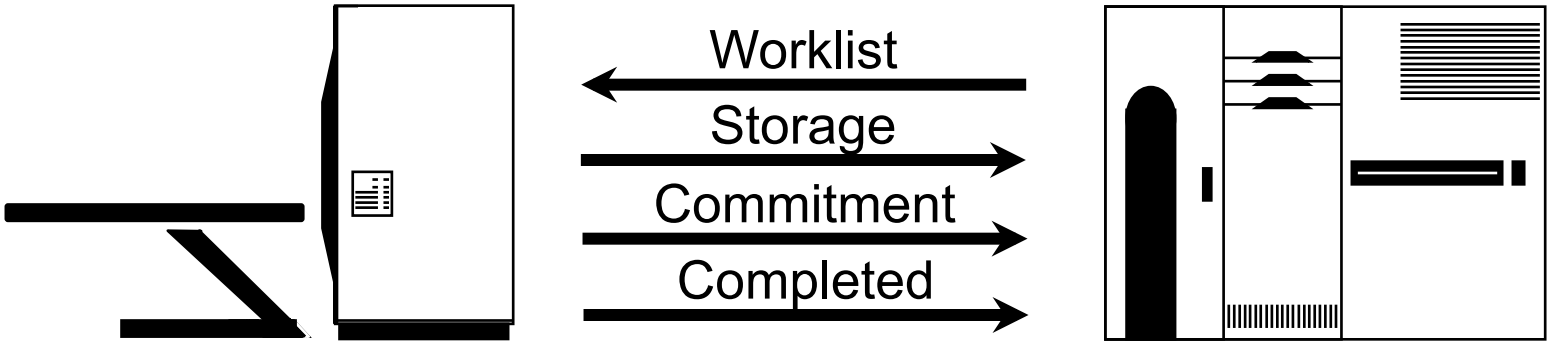
DICOM and Radiology Modality



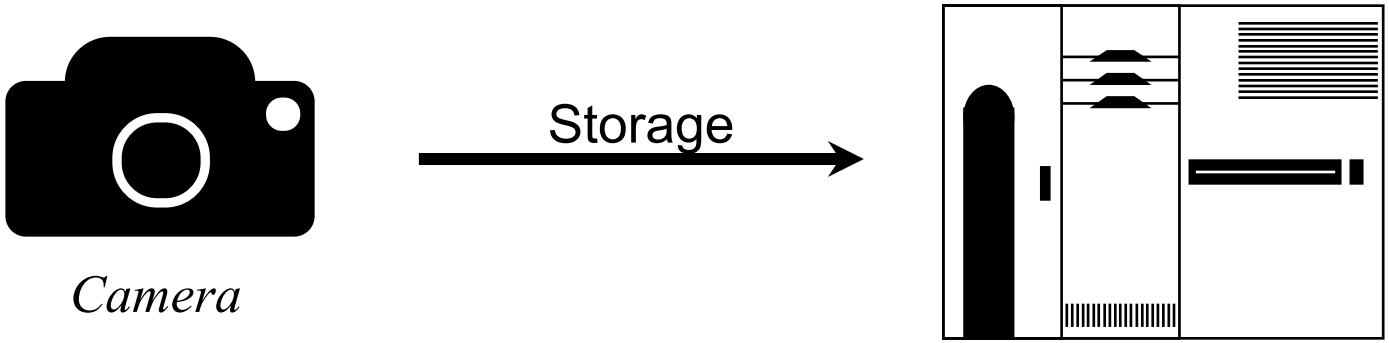
Modality

PACS

DICOM and Radiology Modality



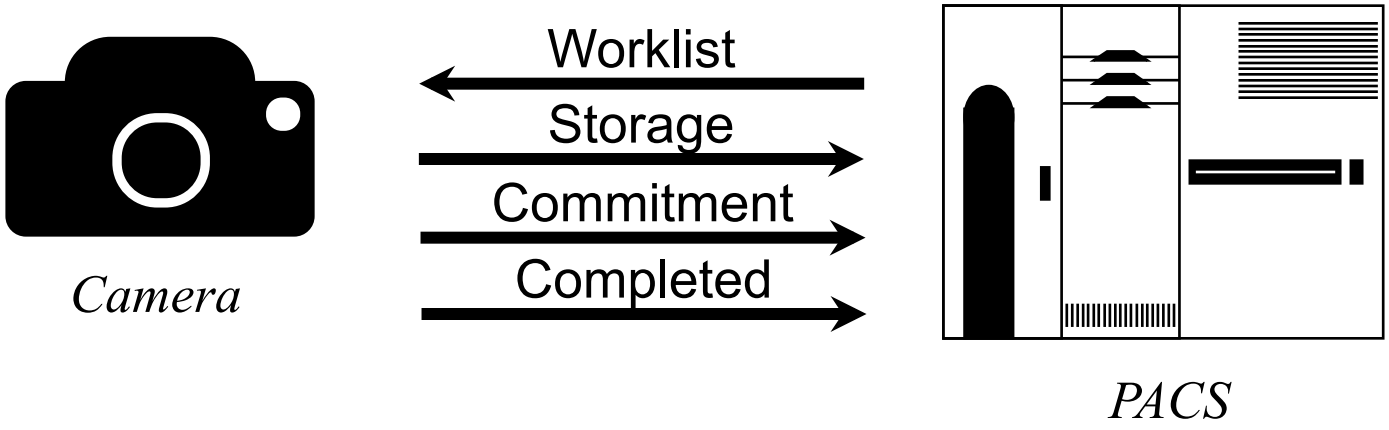
DICOM and Cameras (Dermoscopes, etc.)



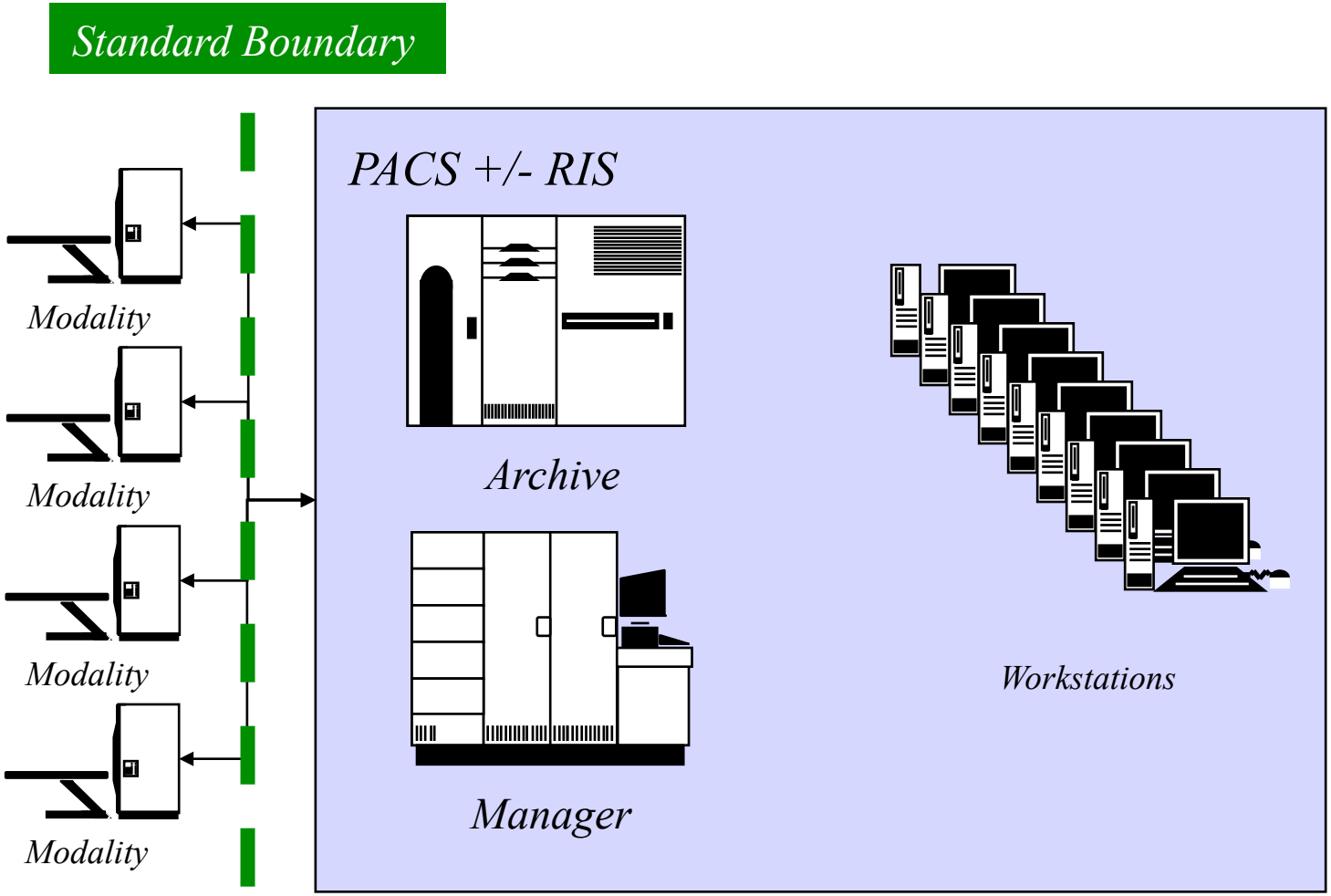
Camera

PACS

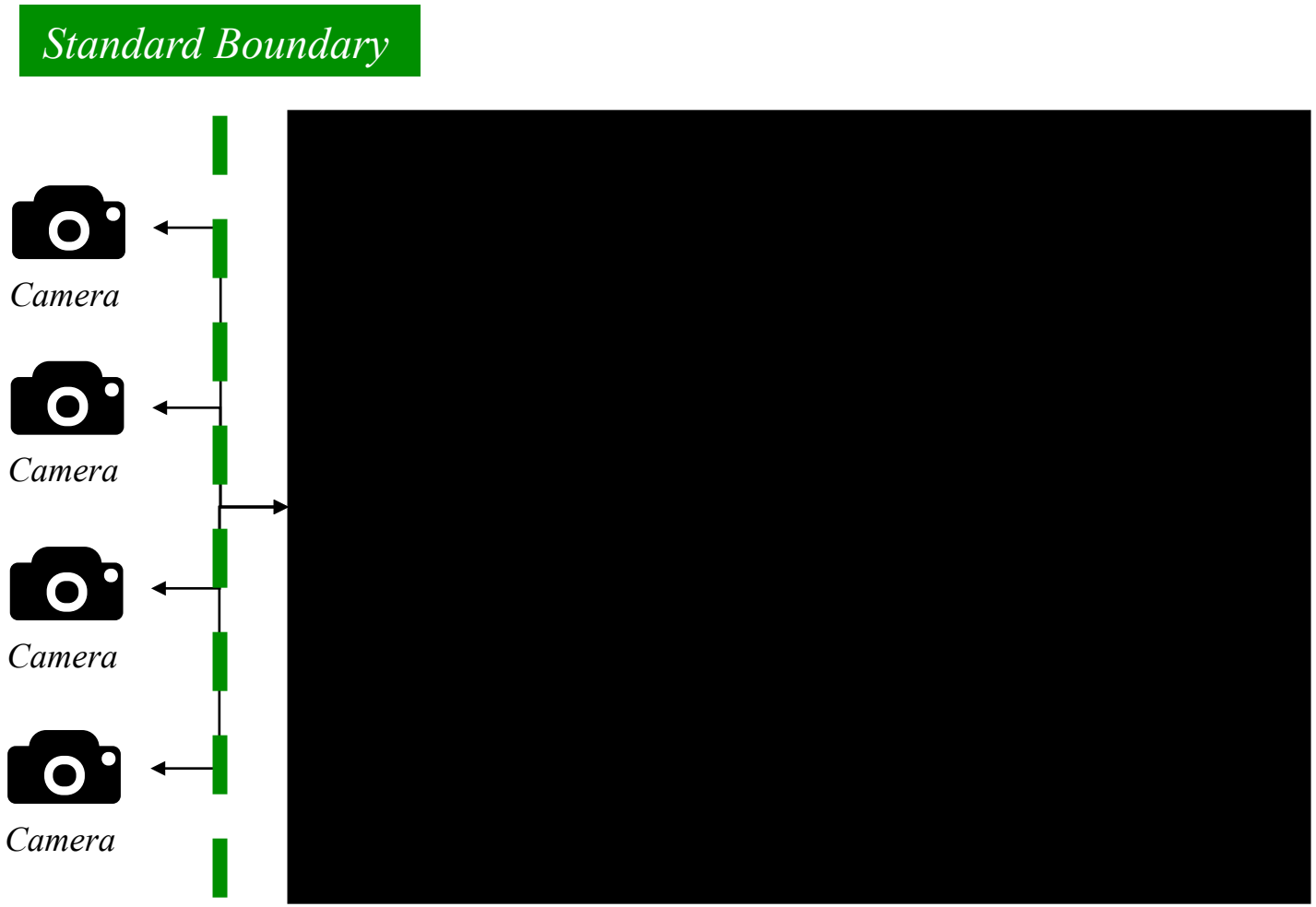
DICOM and Cameras (Dermoscopes, etc.)



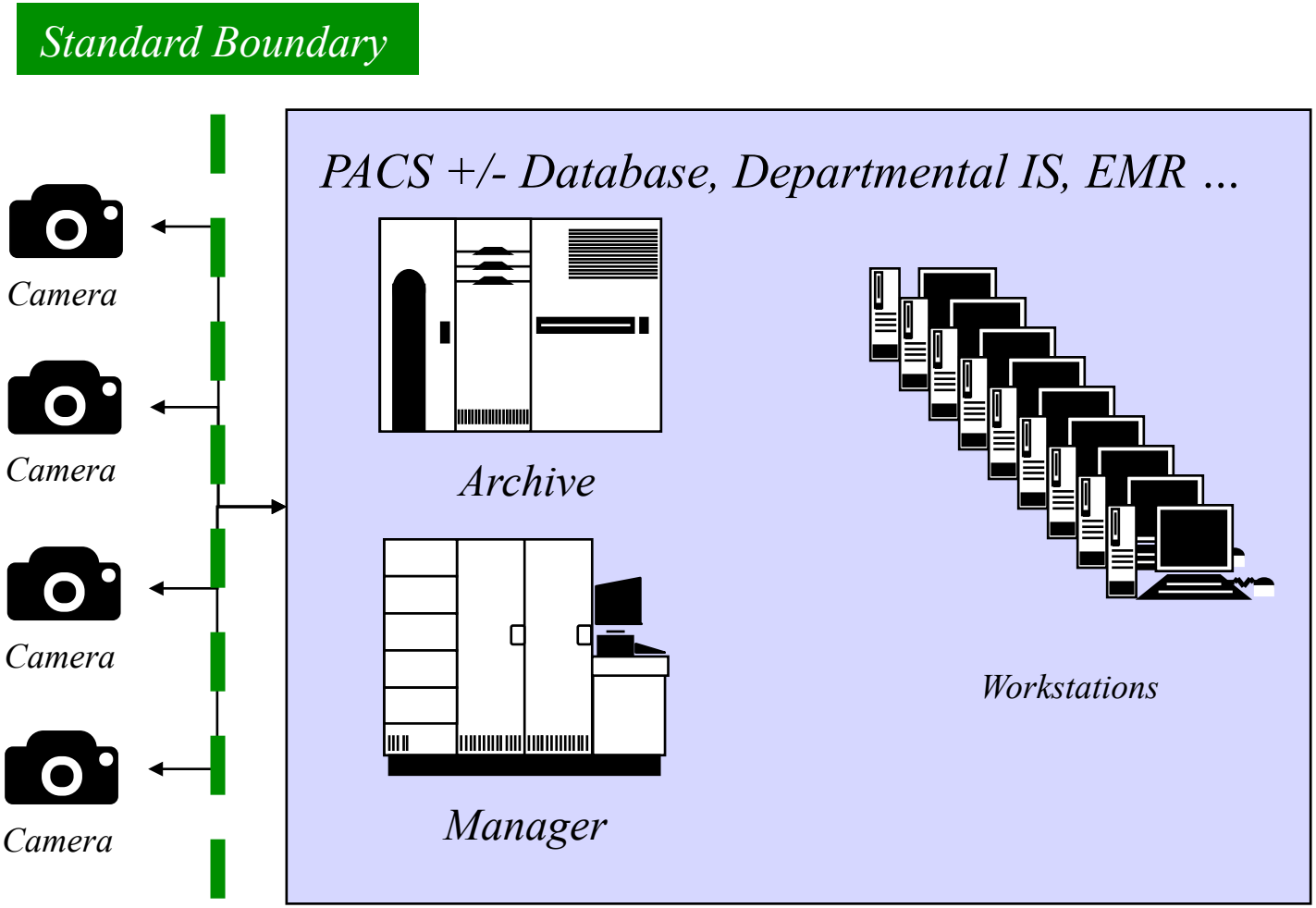
DICOM Modality to PACS



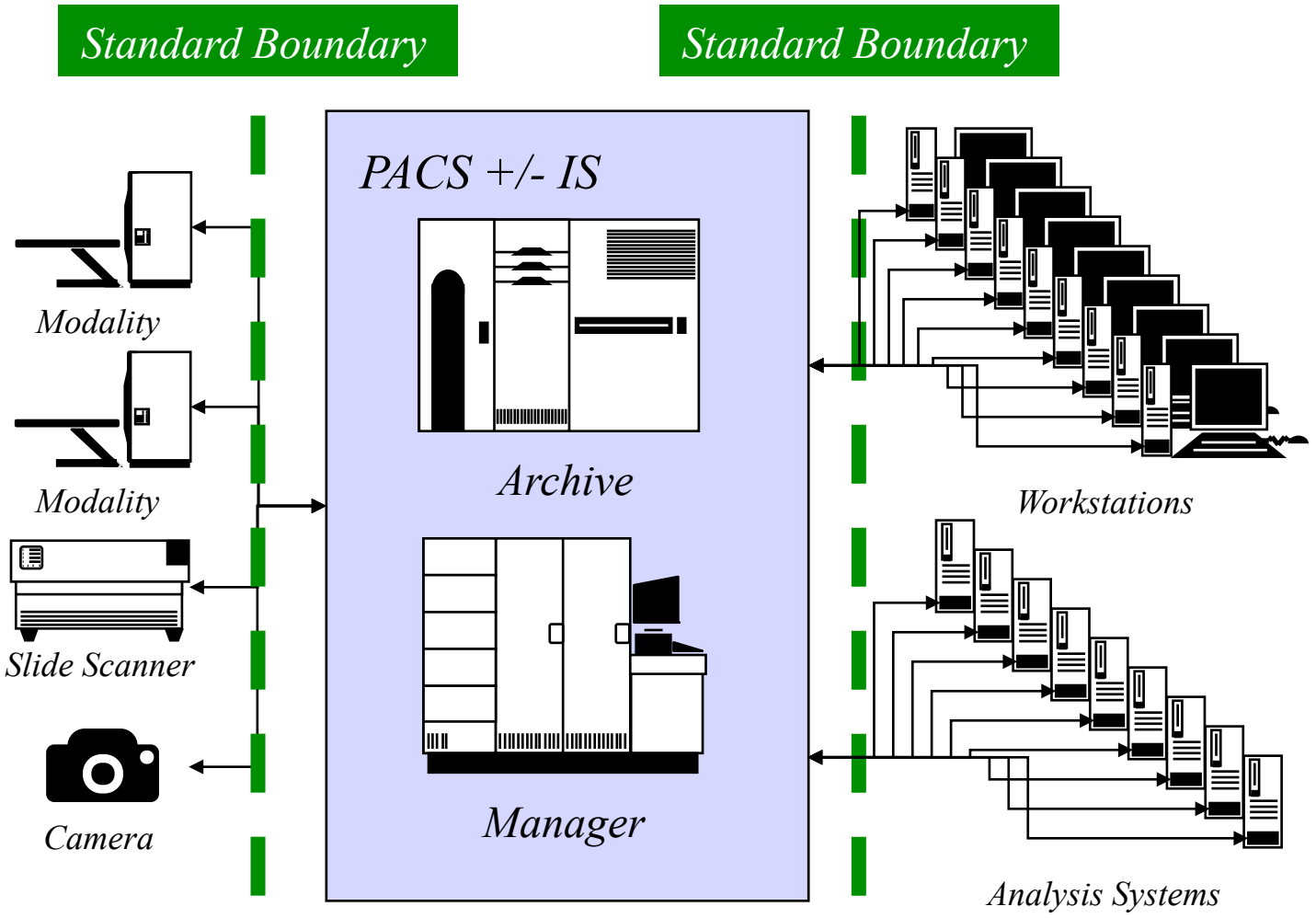
Camera to Black Box



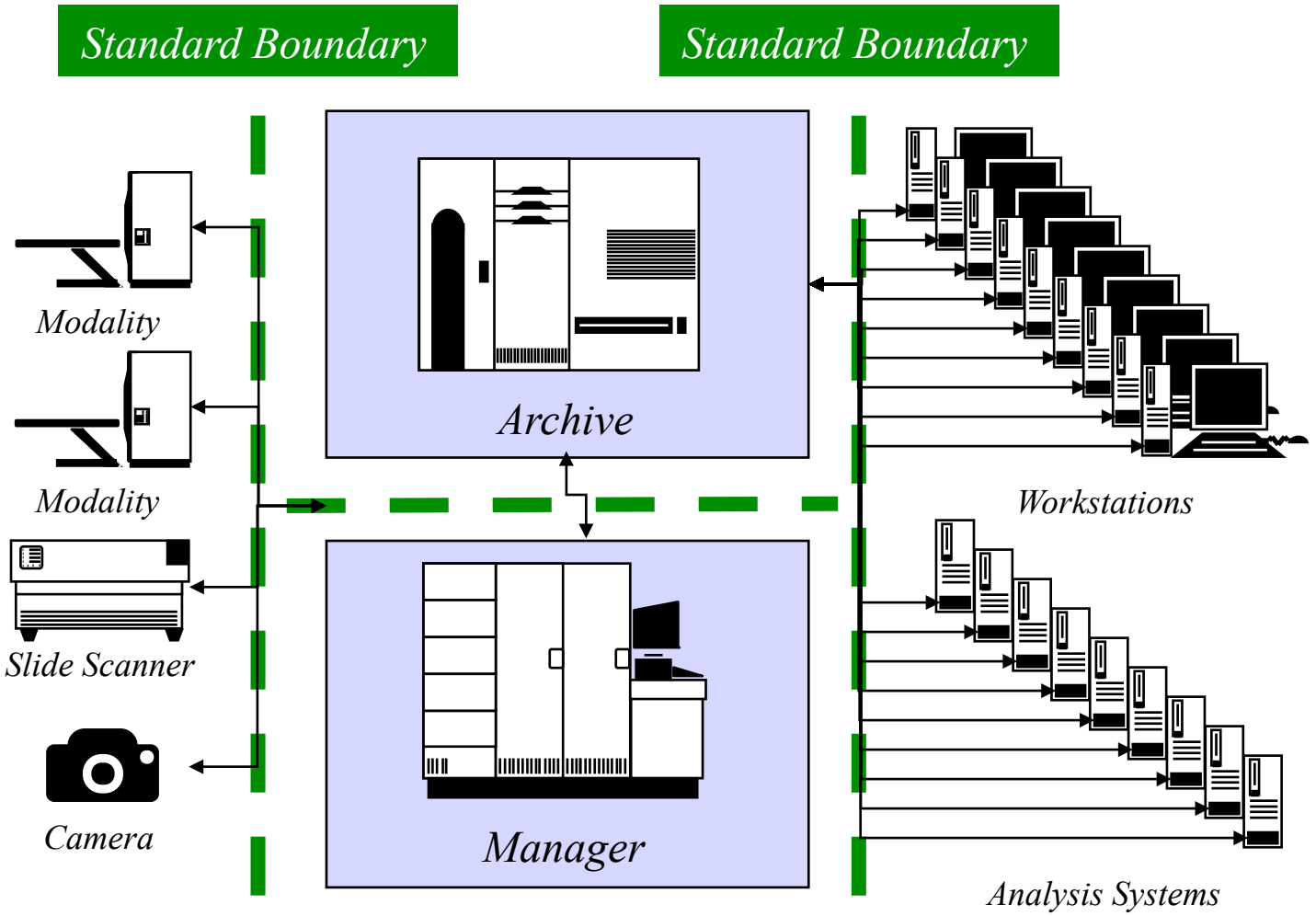
DICOM Camera to PACS



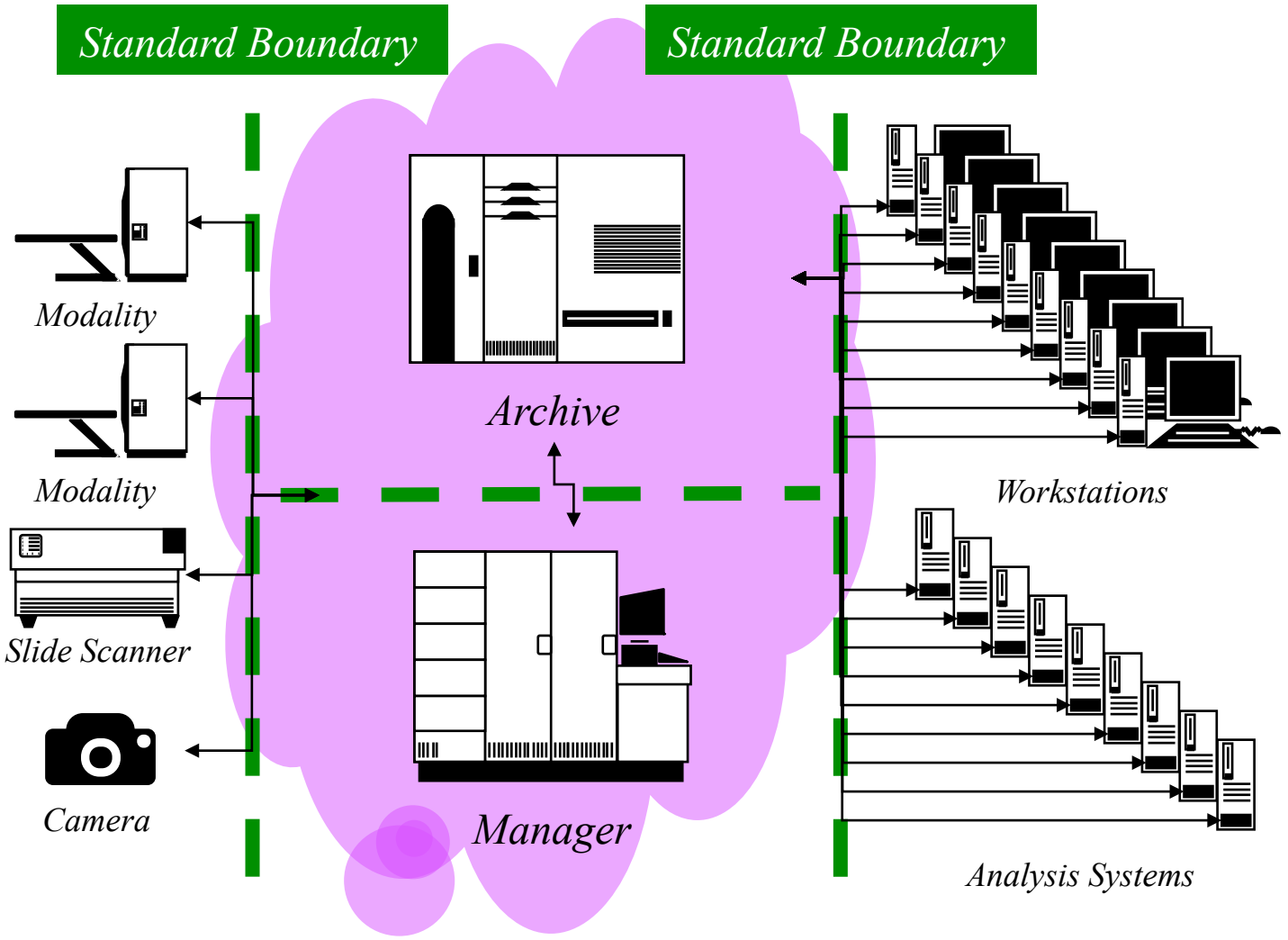
DICOM – Enterprise Imaging



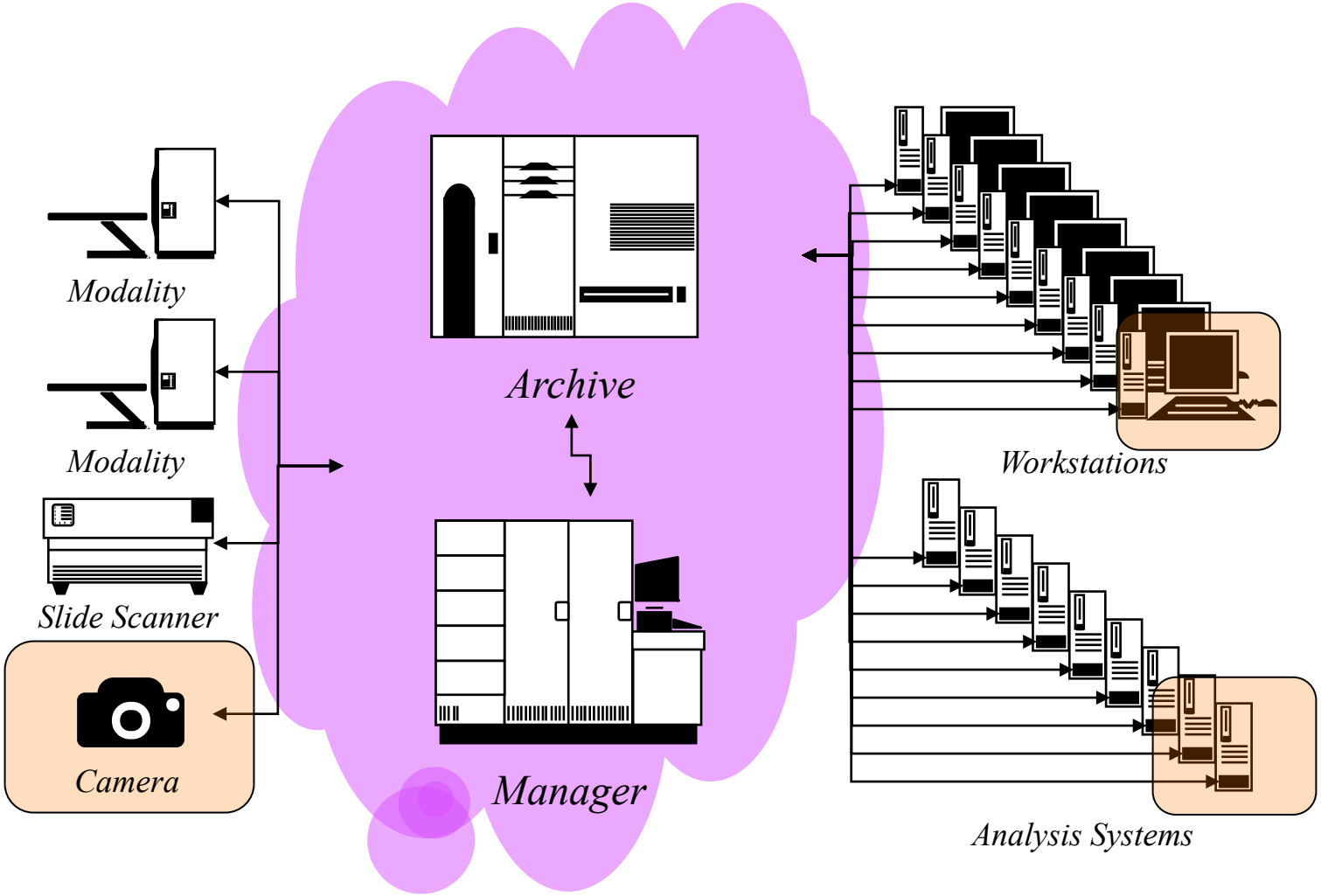
DICOM – Deconstructed PACS



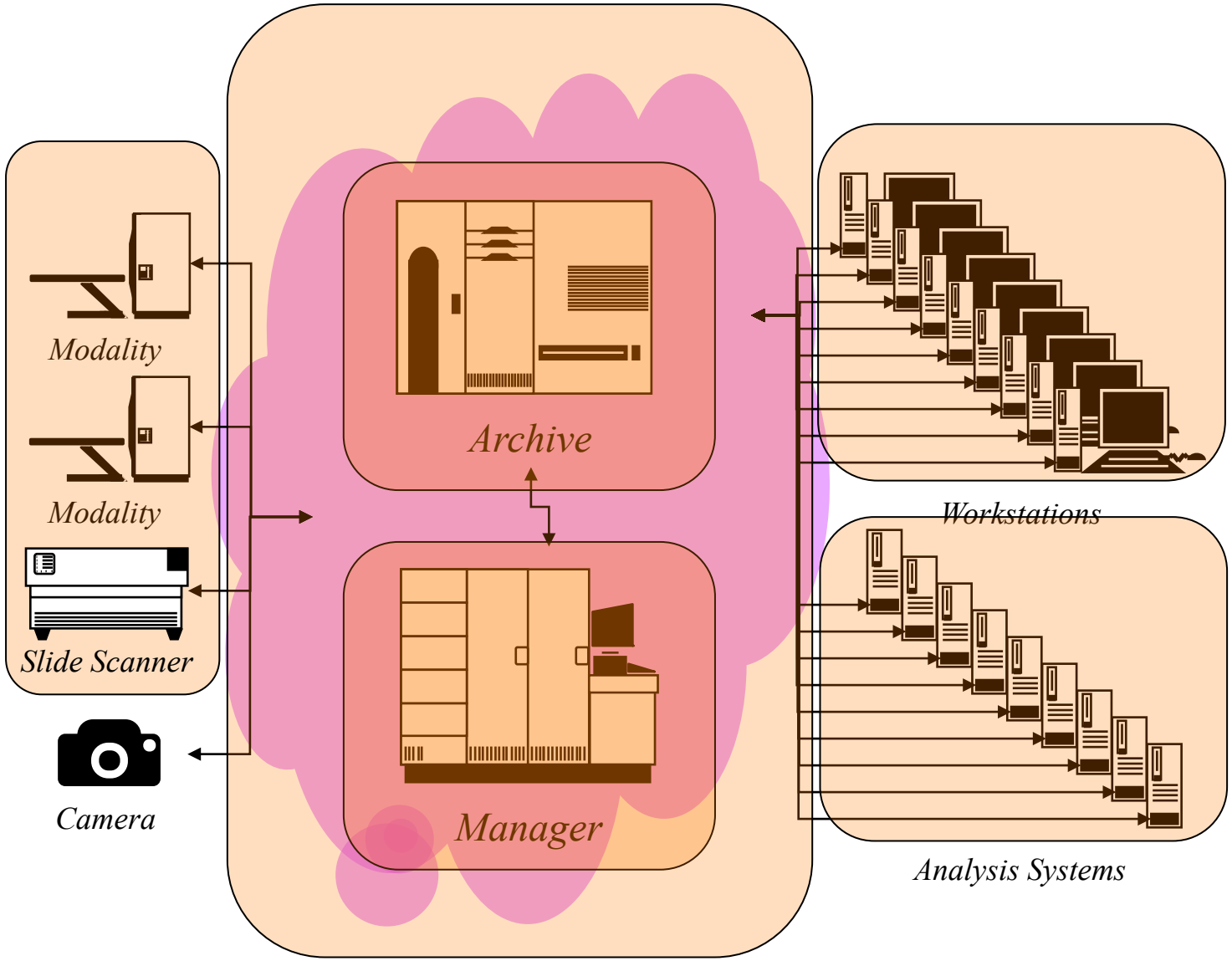
DICOM – Cloud Deconstructed Enterprise Tele* PACS



Dermatologist/Department



Enterprise IT (Someone Else)

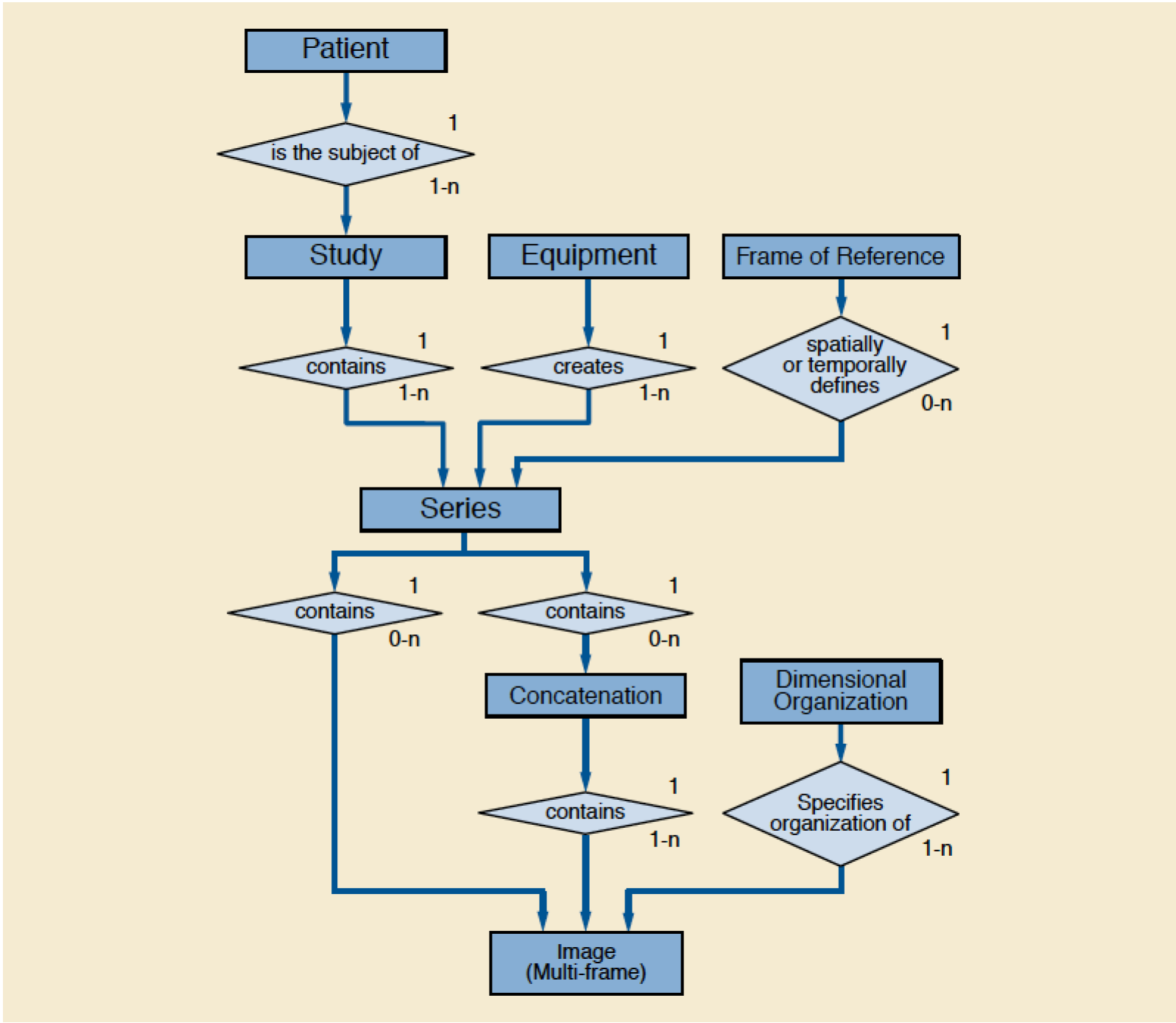


It’s the metadata, stupid

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

Types of Metadata

- Identifying
  - patient, order/request, encounter/visit
- Clinical
  - reason for study, anatomic location
- Descriptive
  - device and settings
  - kind of image
  - pixel physical size (calibration against known size object)
- Encoding related
  - compression
  - color management
- …


Patient
1
is the subject of
1-n
Study
Equipment
Frame of Reference
1
contains
1-n
1
creates
1-n
1
spatially
or temporally
defines
0-n
Series
1
contains
0-n
1
contains
0-n
Concatenation
Dimensional
Organization
1
contains
1-n
1
Specifies
organization of
1-n
Image
(Multi-frame)

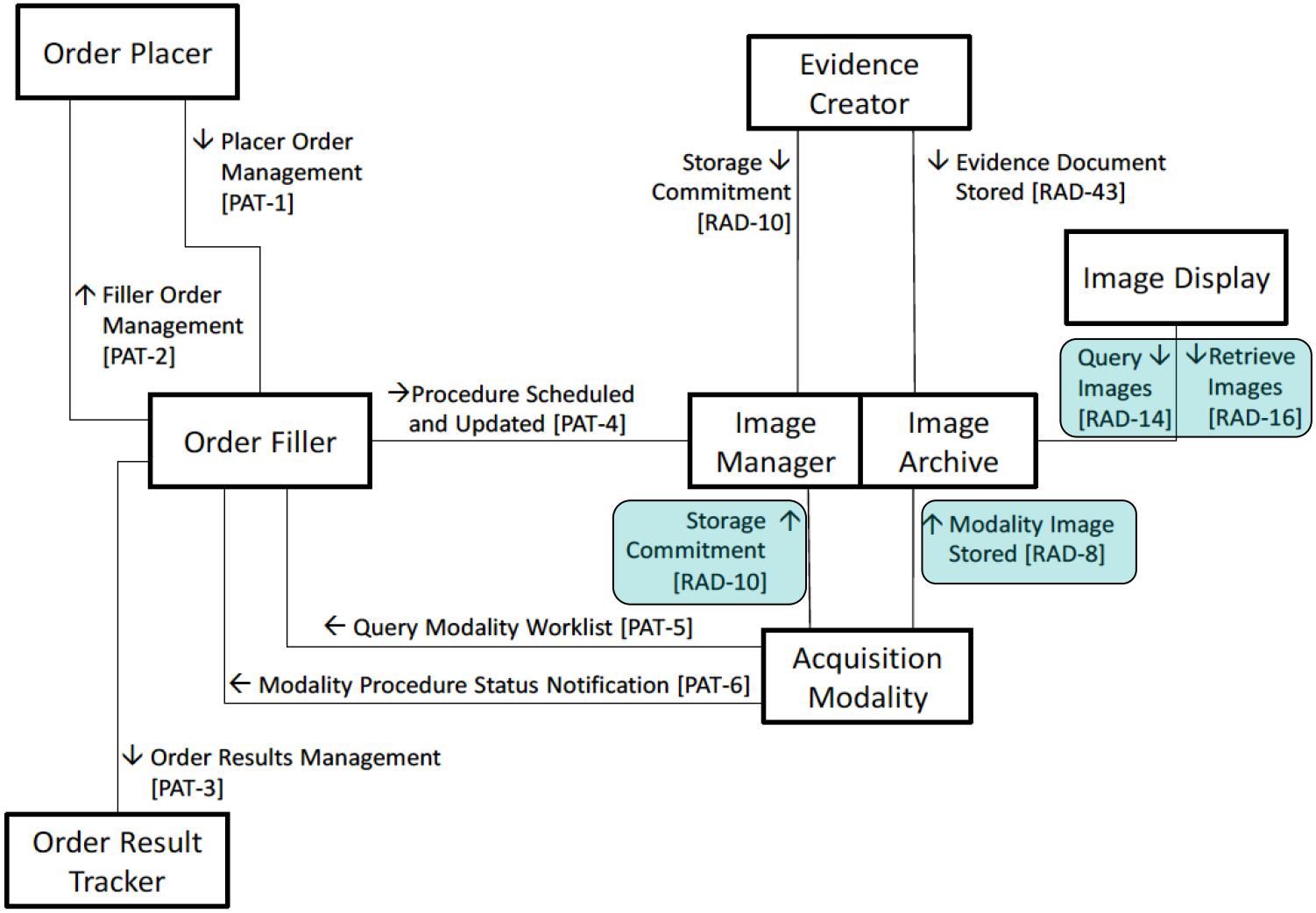

Order Placer
Placer Order Management [PAT-1]
Filler Order Management [PAT-2]
Order Filler
Procedure Scheduled and Updated [PAT-4]
Evidence Creator
Storage Commitment [RAD-10]
Evidence Document Stored [RAD-43]
Image Display
Query Images [RAD-14]
Retrieve Images [RAD-16]
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Image Archive
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Modality Image Stored [RAD-8]
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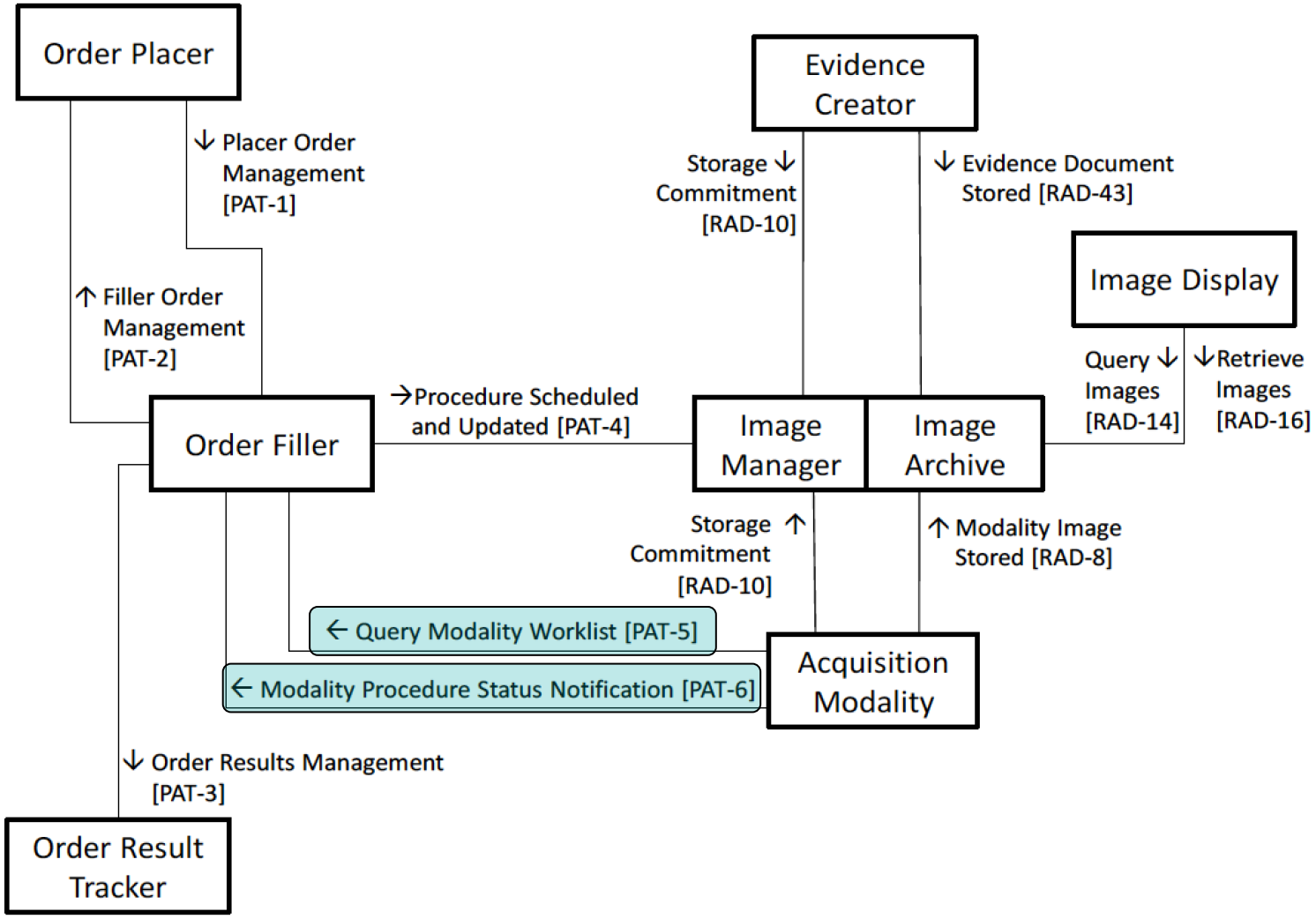
Modality Procedure Status Notification [PAT-6]
Acquisition Modality
Order Results Management [PAT-3]
Order Result Tracker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DICOM – More than a file format

- Payload
  - bulk data (pixels: uncompressed, JPEG, …)
  - metadata (structured, coded, standardized)
- Services
  - transfer (storage)
  - query/retrieve (find and request)
  - workflow management (worklists)
  - object management (errors, lifecycle)
  - annotation (contours, segments, classify)

DICOM Service Choices

- Traditional radiology PACS (“DIMSE”)
  - C-STORE, C-FIND, C-MOVE, +/- C-GET
- “DICOMweb” services (HTTP)
  - “Web Access to DICOM Objects” (WADO)
  - WADO-URI – DICOM PS3.10 file or JPEG
  - “Representational State Transfer” (RESTful)
  - STOW-RS, QIDO-RS, WADO-RS
  - DICOM PS3.10 file, XML, JSON
  - retrieve study/series/instance/frames
  - retrieve DICOM, rendered (JPEG, etc.), metadata

DICOMweb™ Cheatsheet

Study Resources and Actions

Verb	Path	Type	Description
POST	{s}/studies	Store PS3.18 6.6.1	Store instances
GET	{s}/studies?...	Query PS3.18 6.7.1	Query for matching studies
GET	{s}/studies/{studyUID}	Retrieve PS3.18 6.5.1	Retrieve entire study
POST	{s}/studies/{studyUID}	Store PS3.18 6.6.1	Store instances
GET	{s}/studies/{studyUID}/metadata	Retrieve PS3.18 6.5.6	Retrieve metadata
GET	{s}/studies/{studyUID}/series?...	Query PS3.18 6.7.1	Query for matching series in a study
GET	{s}/studies/{studyUID}/series/{seriesUID}	Retrieve PS3.18 6.5.2	Retrieve entire series
GET	{s}/studies/{studyUID}/series/{seriesUID}/metadata	Retrieve PS3.18 6.5.6	Retrieve series metadata
GET	{s}/studies/{studyUID}/series/{seriesUID}/instances?...	Query PS3.18 6.7.1	Query for matching instances in a series
GET	{s}/studies/{studyUID}/series/{seriesUID}/instances/{instanceUID}	Retrieve PS3.18 6.5.3	Retrieve instance
GET	{s}/studies/{studyUID}/series/{seriesUID}/instances/{instanceUID}/metadata	Retrieve PS3.18 6.5.6	Retrieve instance metadata
GET	{s}/studies/{studyUID}/series/{seriesUID}/instances/{instanceUID}/frames/{frames}	Retrieve PS3.18 6.5.4	Retrieve frames in an instance
GET	/{bulkdataReference}	Retrieve PS3.18 6.5.5	Retrieve bulk data

More Information

See http://dicomweb.org and Part 18 of the DICOM Standard, http://dicom.nema.org/standard.html.

Workflow Resources and Actions

Verb	Path	Type	Description
POST	{s}/workitems{?AffectedSOPInstanceUID}	PS3.18 6.9.1	CreateUPS
POST	{s}/workitems/{UPSInstanceUID}{?transaction}	PS3.18 6.9.2	UpdateUPS
GET	{s}/workitems{?query*}	PS3.18 6.9.3	SearchForUPS
GET	{s}/workitems/{UPSInstanceUID}	PS3.18 6.9.4	RetrieveUPS
PUT	{s}/workitems/{UPSInstanceUID}/state	PS3.18 6.9.5	ChangeUPSState
POST	{s}/workitems/{UPSInstanceUID}/cancelrequest	PS3.18 6.9.6	RequestUPS Cancellation
POST	{s}/workitems/{UPSInstanceUID}/subscribers/{AETitle}{?deletionlock}	PS3.18 6.9.7	CreateSubscription
POST	{s}/workitems/1.2.840.10008.5.1.4.34.5/	PS3.18 6.9.8	SuspendGlobal Subscription
DELETE	{s}/workitems/{UPSInstanceUID}/subscribers/{AETitle}	PS3.18 6.9.9	DeleteSubscription
GET	{s}/subscribers/{AETitle}	PS3.18 6.9.10	OpenEventChannel
N/A	N/A	PS3.18 6.9.11	SendEventReport

Payloads

XML

```
<NativeDicomModel>
  <DicomAttribute Tag="00080020"
VR="DT" Keyword="StudyDate">
    <Value
number="1">20130409</value>
  </DicomAttribute>
  <DicomAttribute Tag="00080030"
VR="TM" Keyword="StudyTime">
    <Value
number="1">131600.0000</value>
  </DicomAttribute>
  …
</NativeDicomModel>
```

JSON

```
{
    "00080020": {
        "vr": "DT",
        "Value":
["20130409"]
    },
    "00080030": {
        "vr": "TM",
        "Value":
["131600.0000"]
    },
    …
}
```

(these payloads are excerpts to show payload structure; these are not complete)

ISIC Archive REST API Documentation

Below you will find the list of all of the resource types exposed by the ISIC Archive RESTful Web API. Click any of the resource links to open up a list of all available endpoints related to each resource type.

Clicking any of those endpoints will display detailed documentation about the purpose of each endpoint and the input parameters and output values. You can also call API endpoints directly from this page by typing in the parameters you wish to pass and then clicking the "Try it out!" button.

Warning: This is not a sandbox—calls that you make from this page are the same as calling the API with any other client, so update or delete calls that you make will affect the actual data on the server.

annotation

Show/Hide | List Operations | Expand Operations

dataset

Show/Hide | List Operations | Expand Operations

featureset

Show/Hide | List Operations | Expand Operations

image

Show/Hide | List Operations | Expand Operations

GET	/image	Return a list of lesion images.
GET	/image/{id}	Return an image's details.
GET	/image/{id}/download	Download an image's high-quality original binary data.
POST	/image/{id}/segment	Run and return a new semi-automated segmentation.
GET	/image/{id}/superpixels	Get the superpixels for this image, as a PNG-encoded label map.
GET	/image/{id}/thumbnail	Return an image's thumbnail.
GET	/image/{id}/tiles	Return an image's multiresolution tile information.
GET	/image/{id}/tiles/{z}/{x}/{y}	Return a multiresolution tile for an image.
GET	/image/download	Download multiple images as a ZIP file.
GET	/image/histogram	Return histograms of image metadata.

segmentation

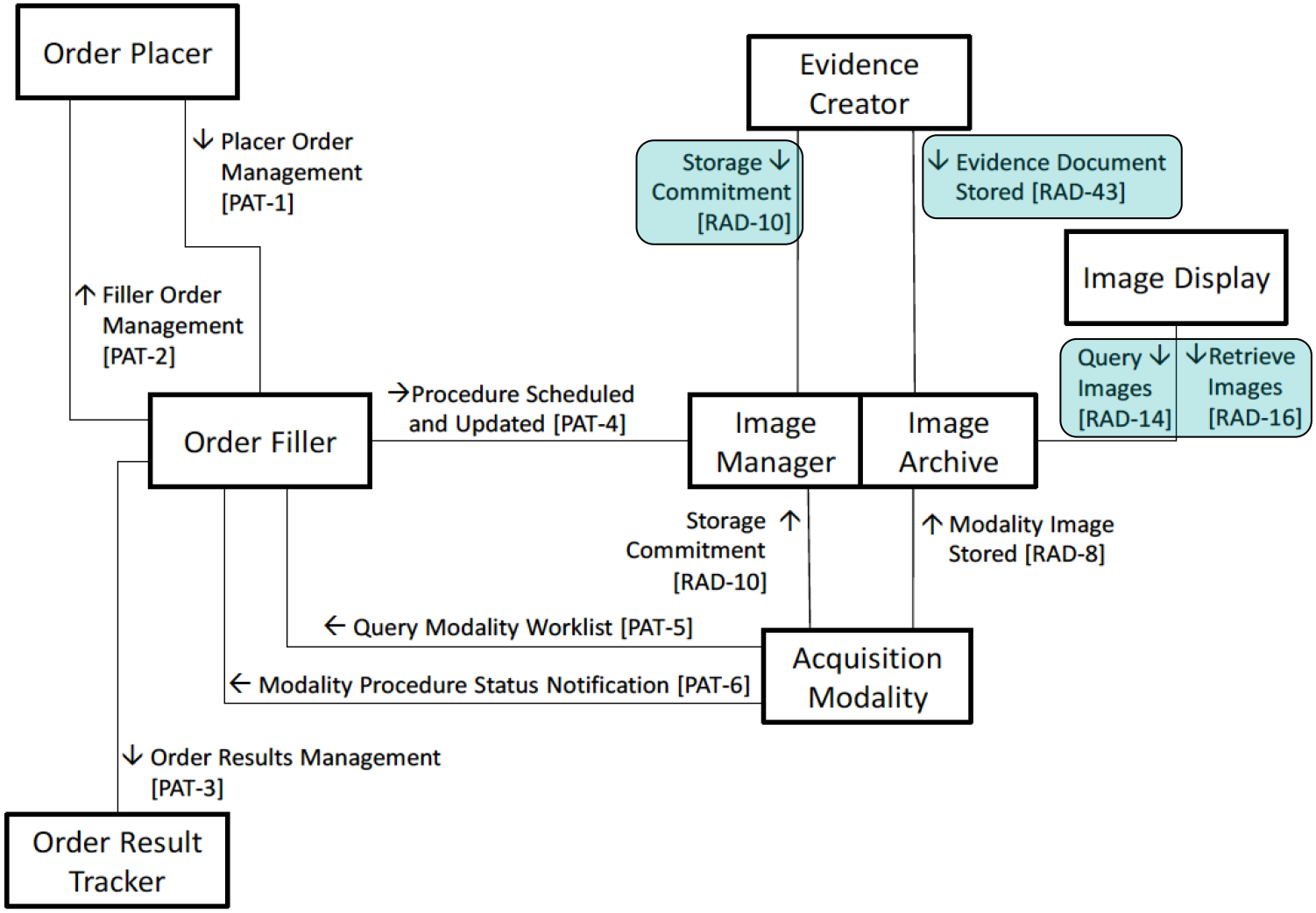
Show/Hide | List Operations | Expand Operations

DICOM and Analysis Systems

- DICOM encoding/services for both inputs ***and outputs***
- Standard acquired image format
- Standard processed result format
- Standard metadata describing input to help analysis

- New images
- Annotations – contours, segmentations, measurements
- Saved to PACS, viewed normally, or as overlay
- Annotations in radiology – regions of interest
- Image fusion in radiology – PET on top of CT

- Facilitates separate regulatory approval and user validation of acquisition/analysis/display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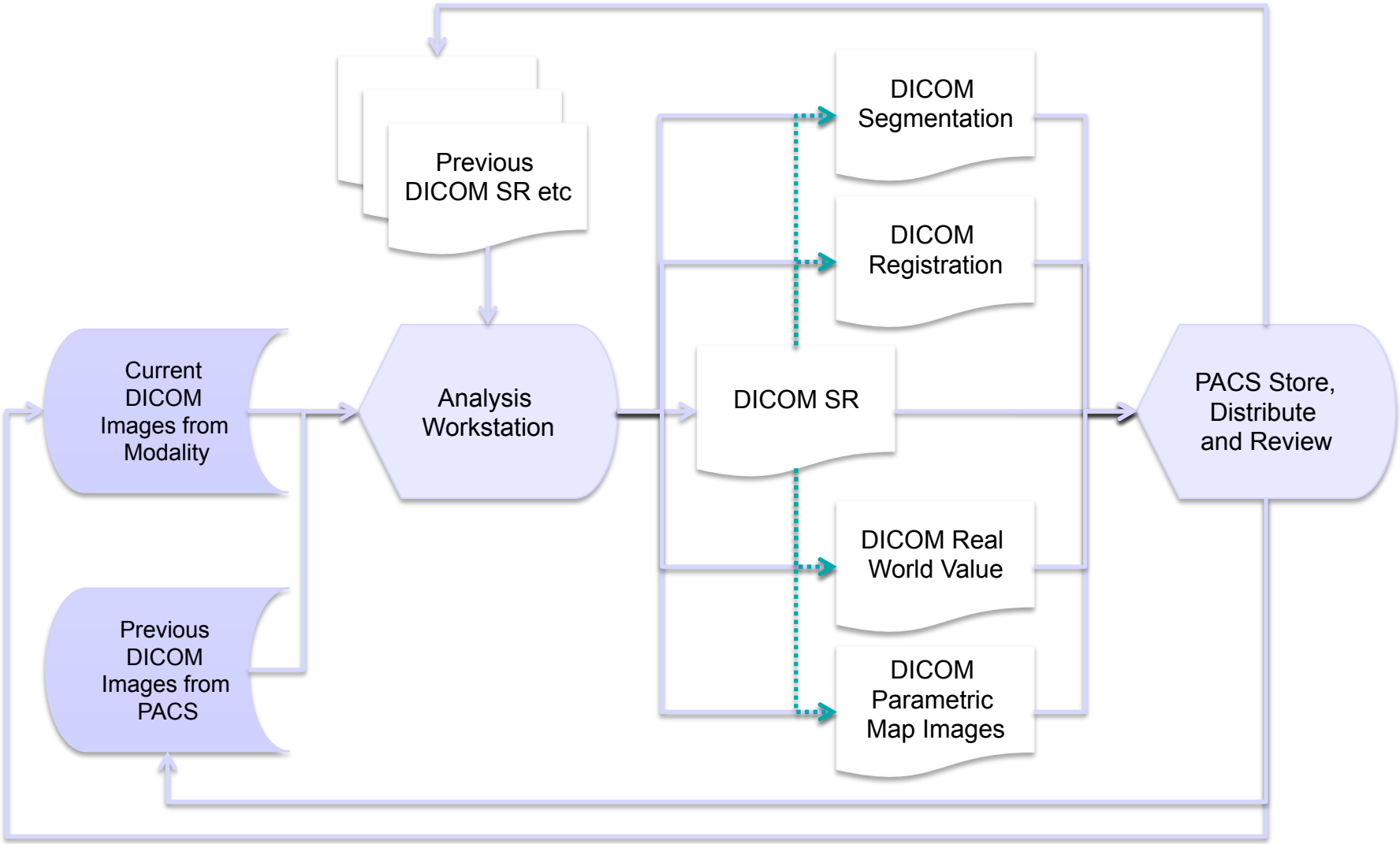
DICOM objects working together



DICOM Dermatology Specifics 1993 to 2017

- 1993 – Initial standard – Secondary Capture, JPEG payload
- 1999 – Sup 15 Visible Light Image for Endoscopy, Microscopy, and Photography – coded anatomy, acquisition context, …

- 1999 – WG 19 – formed (DSC Minutes 1999/06)
- 2001 – WG 19 – disbanded (DSC Minutes 2001/04)
- 2009 – WG 19 – proposal to reactivate (WG6 Minutes 2009/08)

- Just do it (or not) … no need for specific SOP Class, extras?

- 2010 – CP 1017 – Add ICC profile to all color IODs
- CP 1674 on anatomic locations (surface anatomy)
- CP 1736 on EXIF tag mapping to DICOM attributes

WG 19 – 2001 Report – Goals

- *"The American Academy of Dermatology sponsored working group initially defined three high level goals."*
  - *"**Define** those **features** that might be specific for a **cutaneous imaging SOP class**"*
  - *"**Enlist vendors** with enthusiasm for co-developing the cutaneous image SOP class and integrating it into image capture and display equipment."*
  - *"Define a **structured vocabulary** for use in informatics and telemedicine applications in dermatology. These activities will interrelate with the activities of those individuals working on the structured reporting supplement to DICOM."*
- *"In addition, we have recently been asked to comment on the importance of **acquisition context** for dermatology and the importance of **accurate color reproduction** across media in dermatologic images."*

WG 19 – 2001 Report – Results

- Dermatology IOD: *" … for dermatologic image capture, storage, transmission and associated meta data, DICOM supplement 15 provides adequate standardization. In contrast to our original thinking, … **a specific dermatology IOD or SOP class is not necessary**."*
- Vendors: *"… dermatologic digital imaging is a small, nascent market and that **capture device manufacturers are not interested** in writing to a standard such as DICOM."*
- **Structured vocabulary**: *"The American Academy of Dermatology has reviewed this issue and **taken it out of the hands** of the Telemedicine Task Force, the sponsor of Working Group 19."*
- Accurate color reproduction: *"There is more **tolerance for color variation** in dermatologic diagnosis than we think."*
- Metadata: *"It may be that with the advent of **XML**, this too will become an issue that can be **solved without the involvement of DICOM**."*
- *"One is forced to ask whether this group was formed "**before its time**""*

WG 19 – Madden 2009

- *"There is a reason why Working Group 19 has made **no progress for a decade in the middle of a digital revolution** … **missing key incentives** … before … move to integrate digital imaging with diagnosis … :*
- *Although dermatologists **commonly capture digital images, they do not depend on them for diagnosis**.*
- *Since adequate dermatological diagnoses result from face-to-face physical exams, the status quo is viable (but not close to optimal).*
- *Therefore, there is **no concern about using COTS cameras and displays since the images are just for documentation and teaching**.*
- *Use of **inexpensive COTS equipment** is reinforced because it is all that can be supported by the **low reimbursement level** for most dermatologic visits.*
- *The low level of capital equipment expenditure **doesn't attract sufficient vendor investment**.*
- *Unfortunately, the lack of vendor investment suppresses the development, validation and general clinical acceptance of applications for the use of digital images in dermatologic diagnosis and visualization.*
- *The lack of vendor investment hasn't caused clinical concern …"*

CP 1674 - Add Dermatology Anatomic Site Context Group ...

Table CID nnn1. DermatologyAnatomicSites

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-CT Concept ID	UMLS Concept Unique ID	FMA ID	NYUMCCG Numeric Code	NYUMCCG Description	Mayo Numeric Code	Mayo Description
T-D2702	SRT	Crena ani	45327009	C0230121	20234	238	Intragluteal Cleft		
T-D14AC	SRT	External structure of eye region	181142009					508	Eyes
313052	99PMP	Eyelash of left eyelid						105	Eye, left eyelash
313051	99PMP	Eyelash of right eyelid						104	Eye, right eyelash
T-81001	SRT	Female external urethral orifice	279479008	C0458493	85266	504	Urethral Orifice (Female)		
U000413	SRT	Hair	58240005	C0018494	53667			503	Hair
T-AA553	SRT	Iris of left eye	28153001	C0229192	58237			109	Eye, left iris

CP-1736 – Add Photography Attributes [from] EXIF …

Attribute Name	DICOM Tag	DICOM Module	EXIF Tag (hex)	EXIF Tag (dec)	EXIF IFD	EXIF Key	EXIF Type	EXIF Tag description
(ggpa,9405)	Camera Elevation Angle	VL Photographic Acquisition	0x9405	37893	Photo 231	Camera ElevationAngle	SRational	Elevation/depression. angle of the orientation of the camera(imaging optical axis) as the ambient situation at the shot. The unit is degree(°). The range of the value is from -180 to less than 180. If the denominator of the recorded value is FFFFFFFF.H, unknown shall be indicated. Obtaining method or accuracy is not stipulated. Therefore methods like that the photographer manually input the numeric, as an example, are usable.
(ggpa,829a)	Exposure Time	VL Photographic Acquisition	0x829a	33434	Photo	ExposureTime	Rational	Exposure time, given in seconds (sec).
(ggpa,829d)	FNumber	VL Photographic Acquisition	0x829d	33437	Photo	FNumber	Rational	The F number.
(ggpa,8822)	Exposure Program	VL Photographic	0x8822	34850	Photo	ExposureProgram	Short	The class of the program

DICOM & New/Exotic Modalities

- Re-use existing IODs (always, or interim solution):
  - If camera-like, use VL Photo IOD
  - if gross microscopy, use VL Slide
  - if high resolution microscopy, use WSI
  - can always add name-value pairs (Acquisition Context), private attributes, new standard attributes (e.g. EXIF)
  - Can always add new codes (e.g., anatomy, view, …)
- May want new IODs – add Supplements to DICOM
  - ? whole body photography if too large (e.g., need tiles, or non-Cartesian projection/coordinates (like wide-field retinal photography)
  - ? confocal microscopy
  - ? multi-spectral, if not 1 channel or 3 channel (RGB)

Bottom Line

- Can use DICOM just as it is, right now, for most devices
  - can use off-the-shelf conversion solutions if acquisition devices are not DICOM compatible out of the box
  - can use DICOM file format (metadata) and protocols
- Can improve DICOM incrementally as necessary
  - but not a reason to wait – “Just Do It” (Nike)
- Should use DICOM if you:
  - want “interoperability”
  - don’t want metadata to be trapped in a vendor-specific silo
  - ever want to migrate when vendor/product goes end of life
  - want to leverage enterprise infrastructure (archival, security, …)
  - want to analyze with 3rd party tools (“CAD”)
  - want to share (import/export/refer/teledermatology)
  - want “integrative” imaging (with other image types; MDTM, …)

DICOM WG 19 – Action Items

- Reactivate
- Secretariat – ISIC? IDS? AAD?
- F2F and virtual meetings – with conferences?
- Vendor engagement
- Success stories – existing use in institutions, teledermatology?
- Add DICOM format, services (esp. web) to ISIC archive?
- Terminology: free; relationship with SNOMED, FMA, UMLS
- Color: need dermatologists to join ICC MIWG
- Privacy: review/extend DICOM de-identification profile and options