HL7 FHIR DevDays 2017

HL7® FHIR®

DICOM and Imaging Tools

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Quick Introduction

AGFA HealthCare

Mohannad Hussain

- Software engineer
- Team lead at Agfa HealthCare, Integrations and Customizations
- Coordinator, annual SIIM Hackathon

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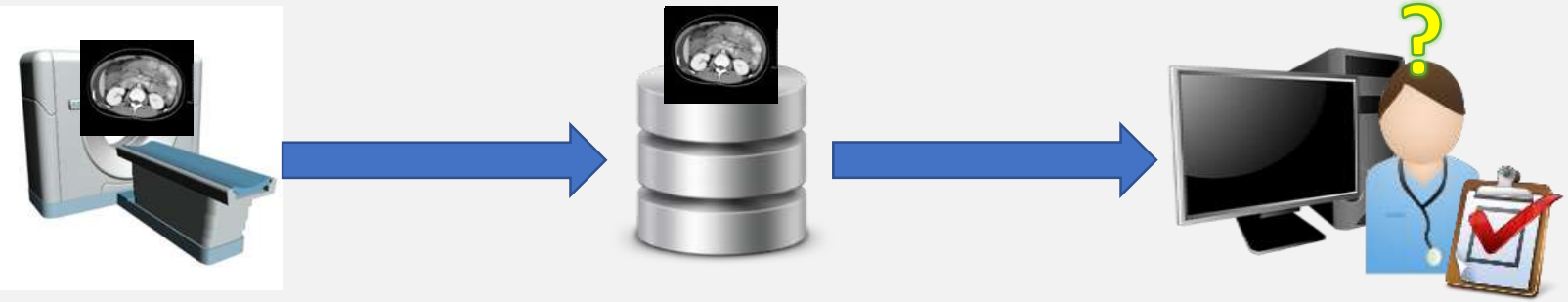
FUNDAMENTAL DICOM CONCEPTS

DICOM is Imaging

Standard for handling, storing, printing, and transmitting information in medical imaging, and includes both a file structure and communication protocol

https://en.wikipedia.org/wiki/DICOM

Main Actors



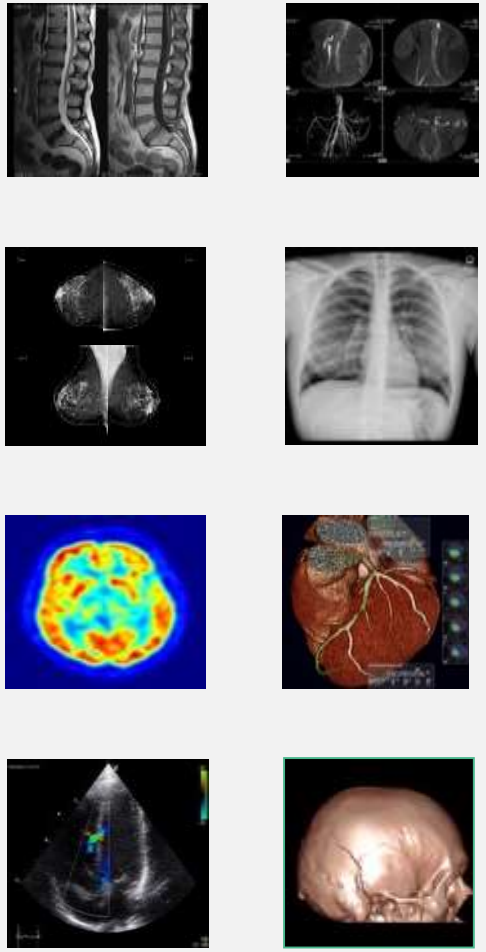
- Modality acquires images and transmits them to archive
- Images stored in PACS (Picture Archive and Communication System)
- Optional: Copy to VNA (Vendor Neutral Archive) for long-term storage
- Radiologists/users access images using viewers (whether thick client or web-based)

PACS/VNA at a glance

- Speak “traditional” DICOM, aka DIMSE
  - C-FIND for query
  - C-MOVE for retrieval
  - C-STORE for storage
- Some support WADO-URI for HTTP-based retrievals
- Some may speak “modern” DICOM, aka DICOMweb
  - QIDO-RS for query
  - WADO-RS for retrieval
  - STOW-RS for storage

Store Images

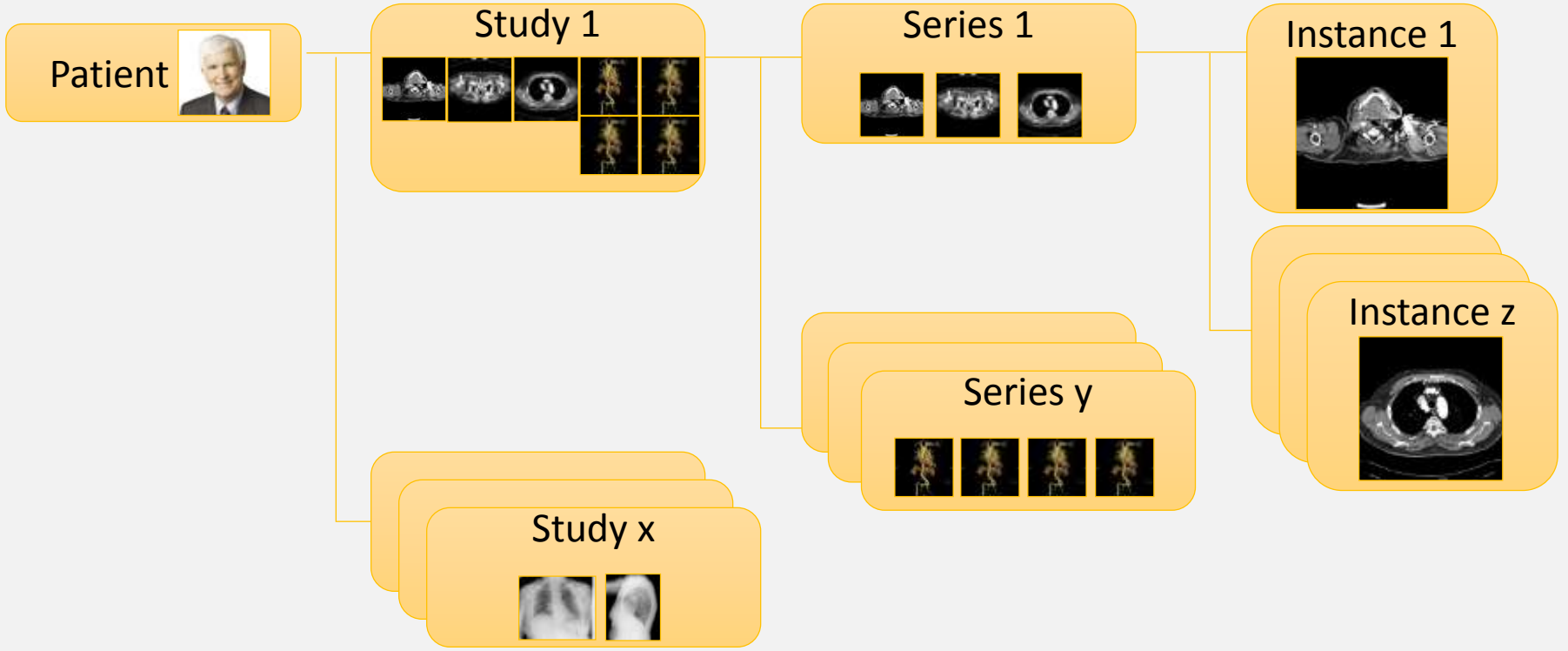
- DICOM stores images
  - All kinds of images
  - CT, MR, X-Ray, Ultrasound, Angiography, PET, Ophthalmology, Documents, …
  - Single & Multiframe; Volumes & Cines; B&W & Color; Original & Processed
- DICOM helps to manage images
  - Not just pixels → significant meta-data
  - Patient identification & demographics, the order, acquisition, workflow context…
  - Can query / sort / autoroute / manage



Key Objects and Markup

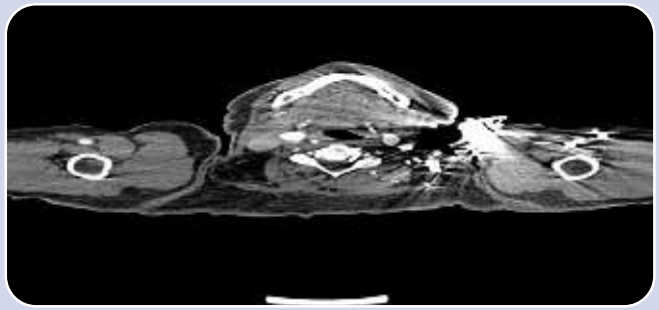
- Key Objects
  - Way to represent a set of images besides “all of the images”
  - For example, “marked for review”, “marked for quality issues”, “XDS publishable set”
- GSPS
  - Markup and annotations on the images
  - Includes factors like window/level
  - Applied on images or image sets

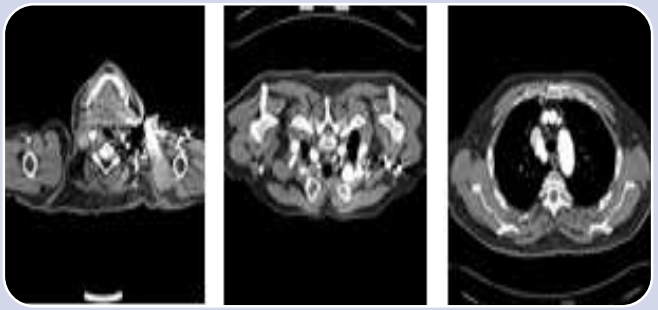
Image Hierarchy

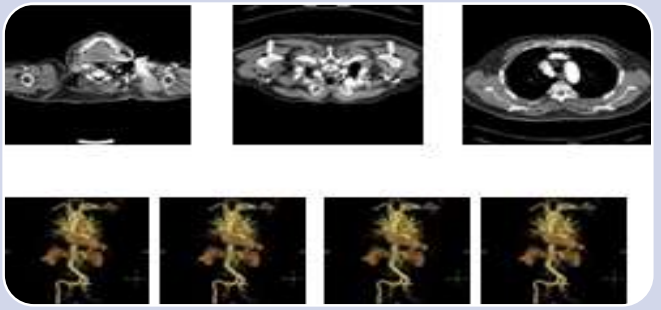


Each patient has x studies , which has y series,
which has z instances
… and could have f frames.

Image Metadata







Study

- **Study UID**
- Date of Study
- Description
- Refer Physician
- Accession
- …

Series

- **Series UID**
- Modality
- Description
- Series Number
- Body Part
- …

Instance

- Instance UID
- Height
- Width
- Position
- SOP Class UID
- …

Terminology

- Service + Object = Service Object Pair
  - “Image Storage” + “MRI” = “MRI Image Storage”
- SOP Class used to defined a file type
- SCU = Service Class User (“client”)
- SCP = Service Class Provider (“server”)
- AE = Reference to the Application Entity (a client or a server)
  - AET = AE Title

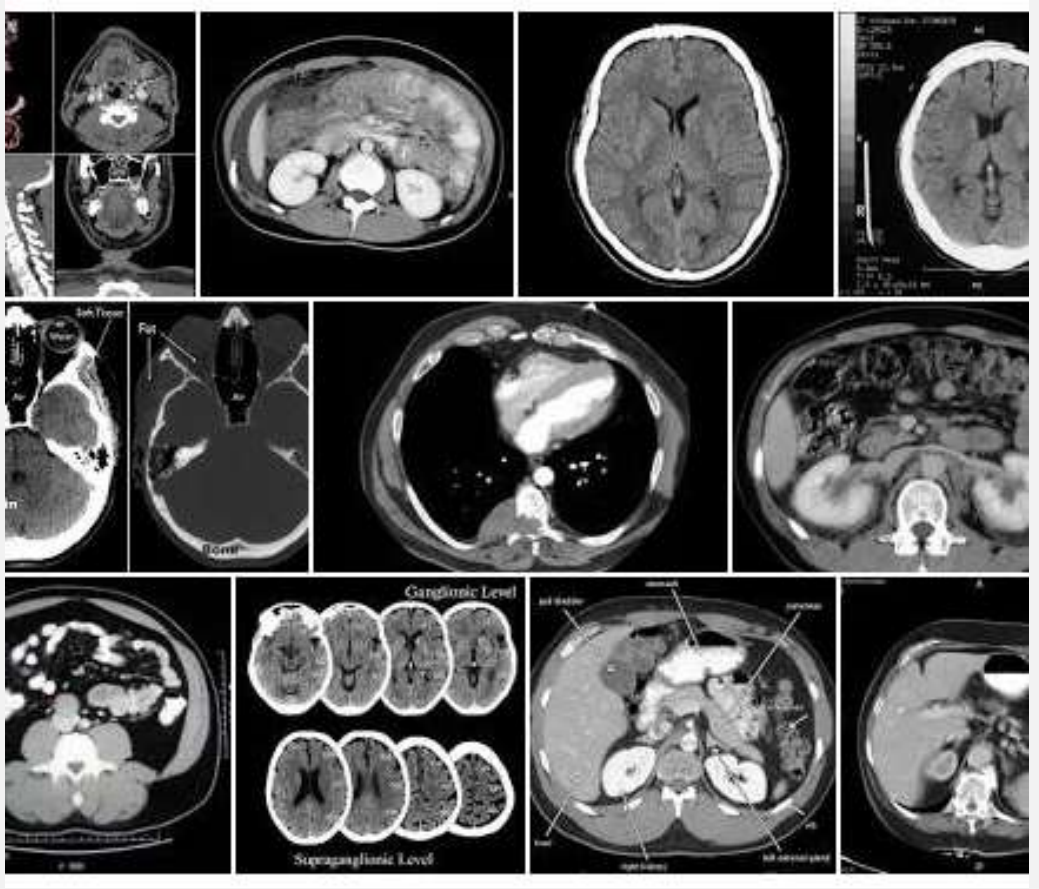
DICOM Metadata Tags

- DICOM's binary structure for representing metadata; i.e.,
  - (0010,0010) -> Patient name
  - (0008,0090) -> Referring physician name
- Described in DICOM PS3.6
- Tags are defined using a VR (a data type) and an VM (multiplicity factor)

DICOM HANDS-ON

Get DICOM Images

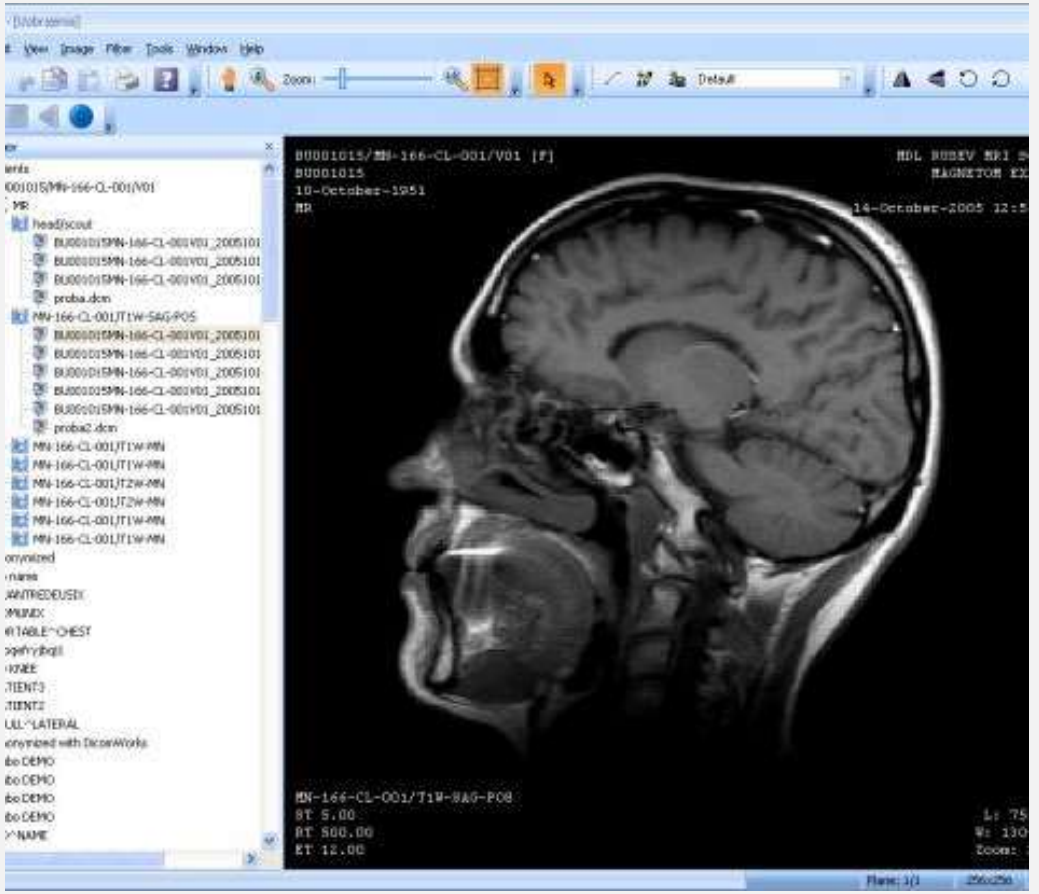
- SIIM Hackathon Dataset
  https://goo.gl/k5LpP3
  - Advantage: Lines-up with FHIR data
- Cancer Imaging Archive
  https://goo.gl/RY2cFD
  - Advantage: Wide selection/variety



Get a DICOM Image Viewer

- MicroDicom - Native Viewer
  http://www.microdicom.com/

- Cornerstone – Web Viewer
  https://goo.gl/hGa1AR

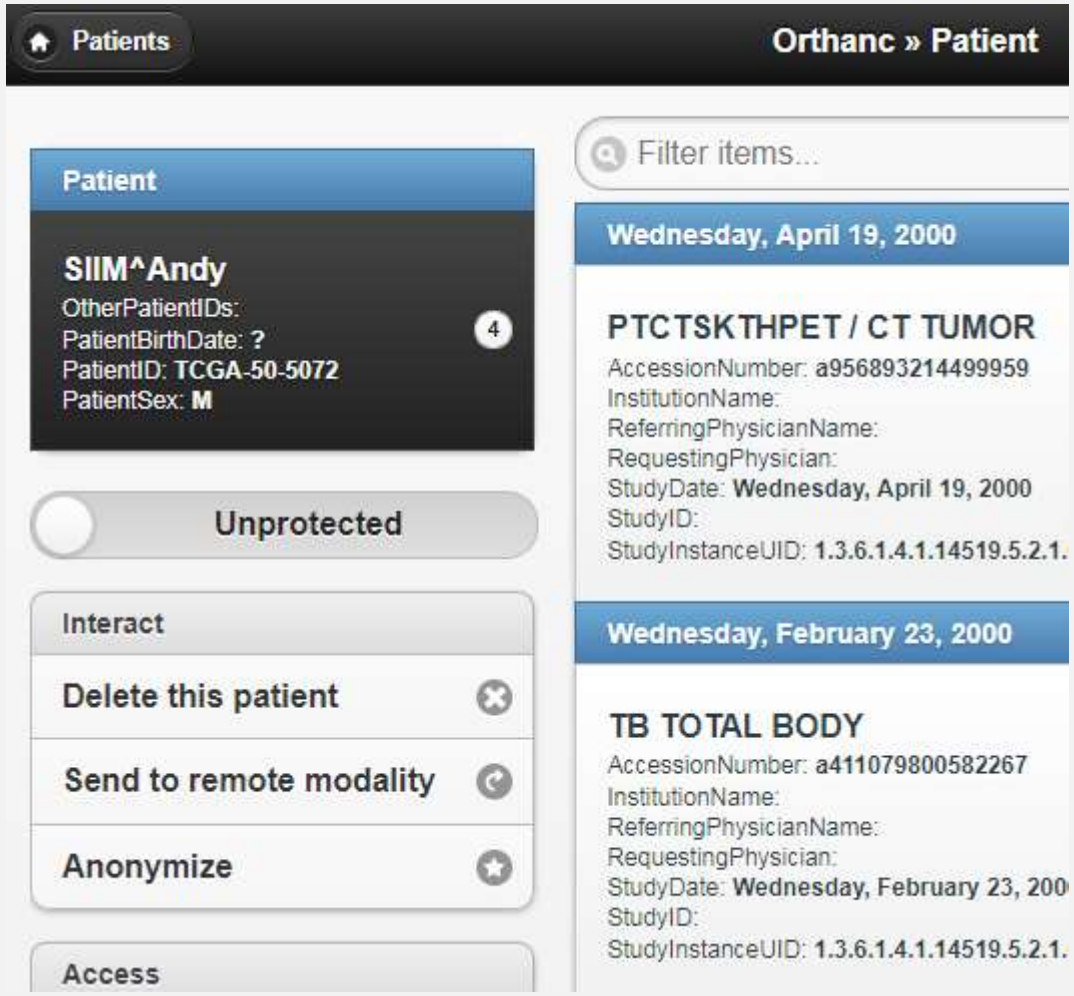


Get a DICOM Toolkit

- DVTk http://www.dvtk.org/
- ConQuest https://goo.gl/j6tzK4
- Ginkgo http://ginkgo-cadx.com
- DCM4CHE – CLI (Win & Linux)
  V2: https://goo.gl/ojb2Qt
  V3: https://goo.gl/JUR9Zb

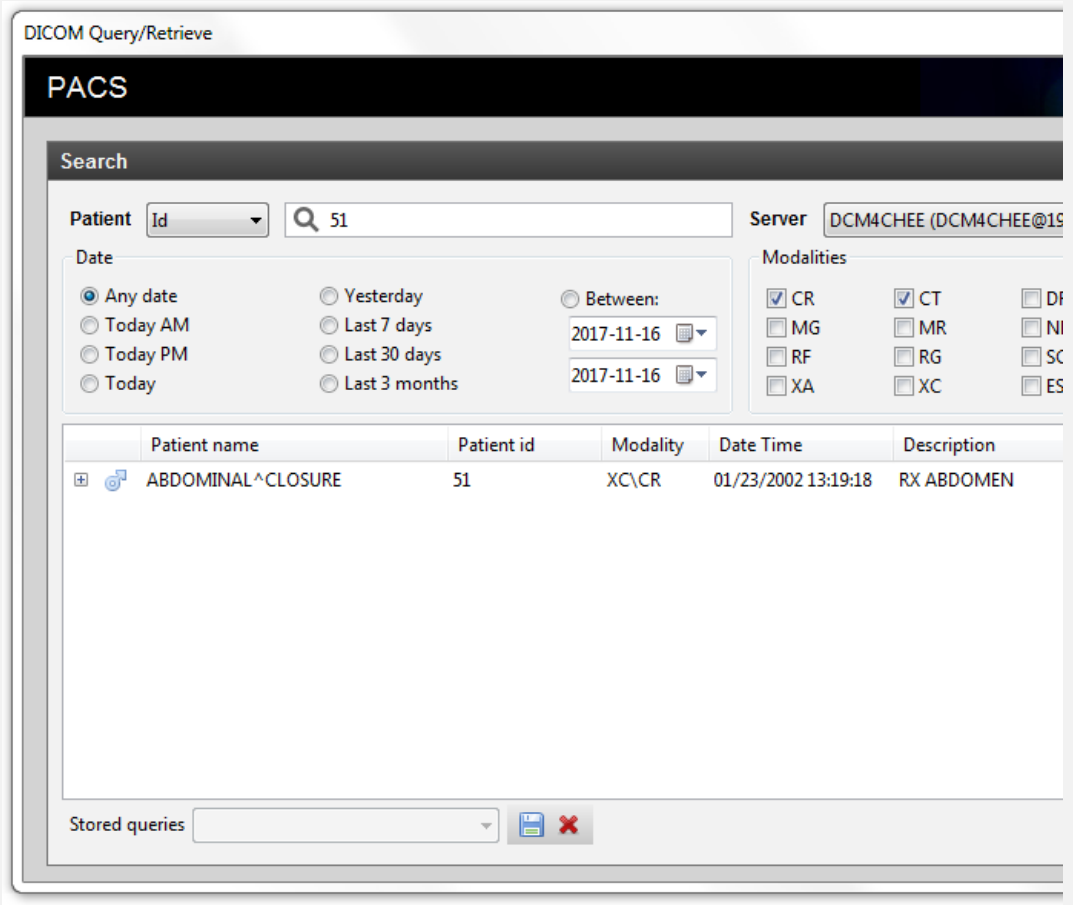
Store the images in a PACS/VNA

- Orthanc
  - Docker image: https://goo.gl/nBMDpV
  - Step by step: https://goo.gl/Bm65La
- DCM4CHEE
  - Docker image: https://goo.gl/bn363J

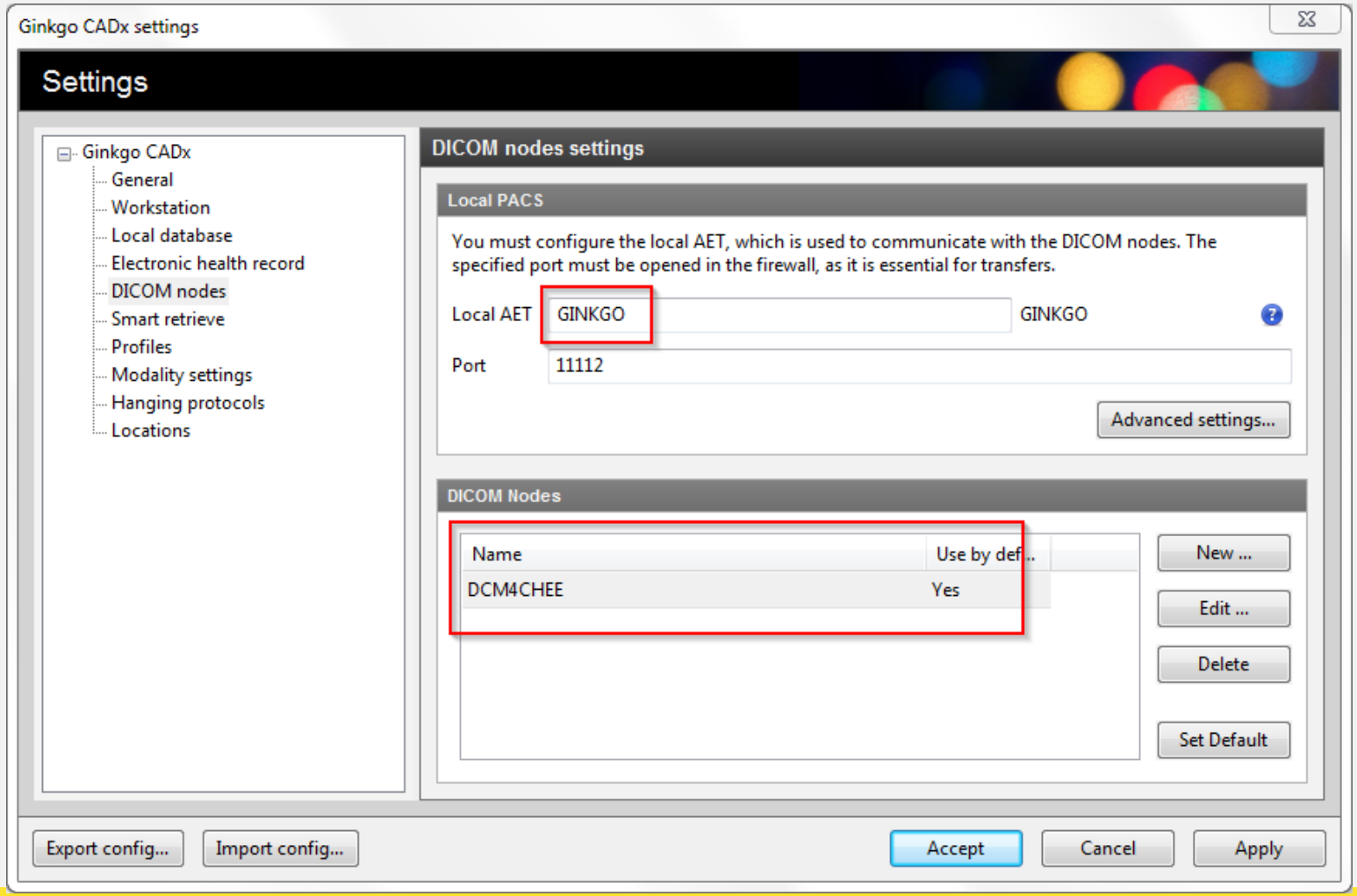


DICOM DIMSE Requests

- C-FIND for search
- C-MOVE for retrieval (aka download)
- C-STORE for storage (aka upload)
- C-ECHO for ping



Ginkgo Configuration



Dcm4che Demos

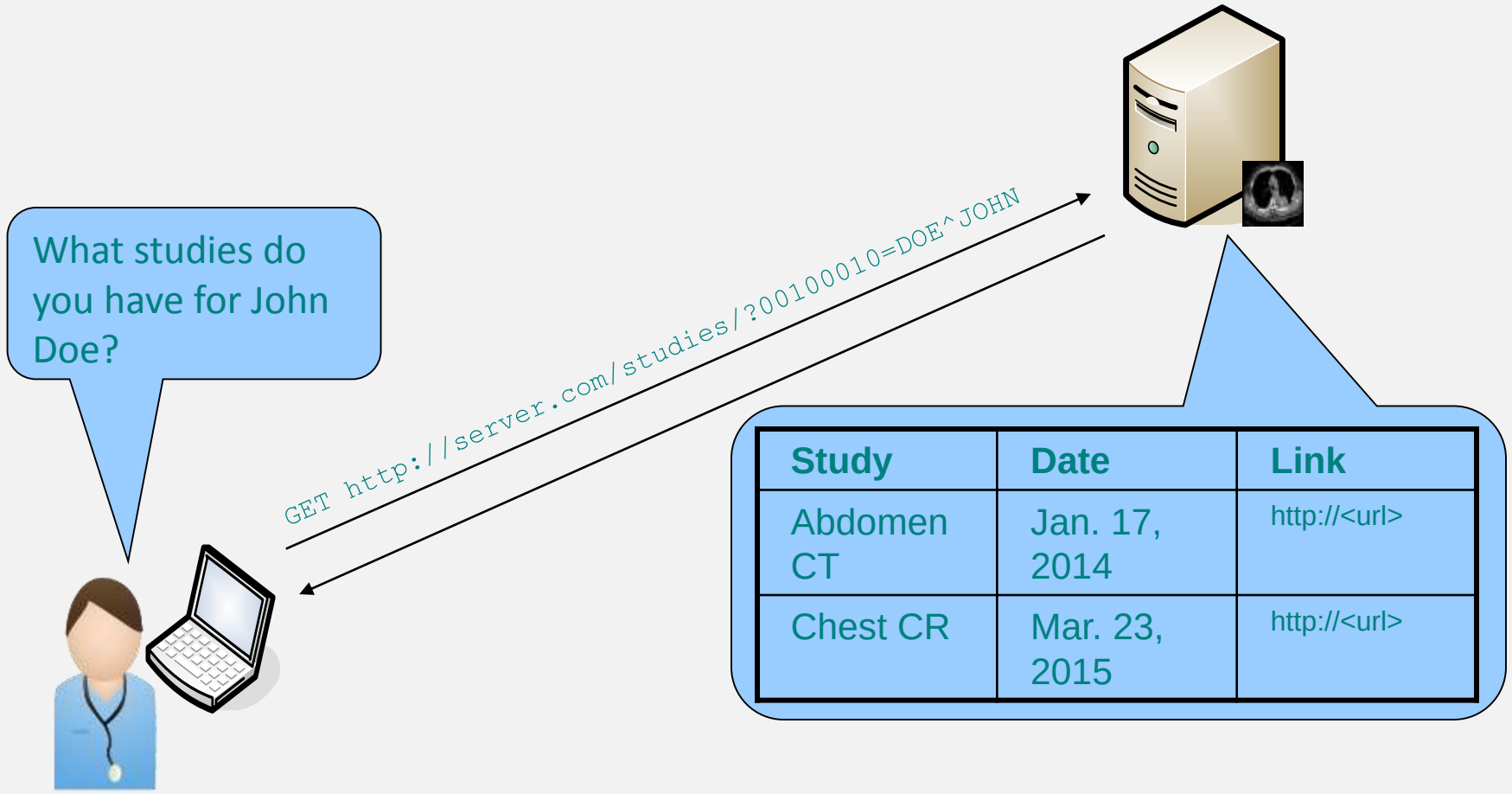
- dcmecho
- dcmqr
- dcm2xml
- dcm2jpg

DICOMWEB HANDS-ON

DICOMweb™ Services

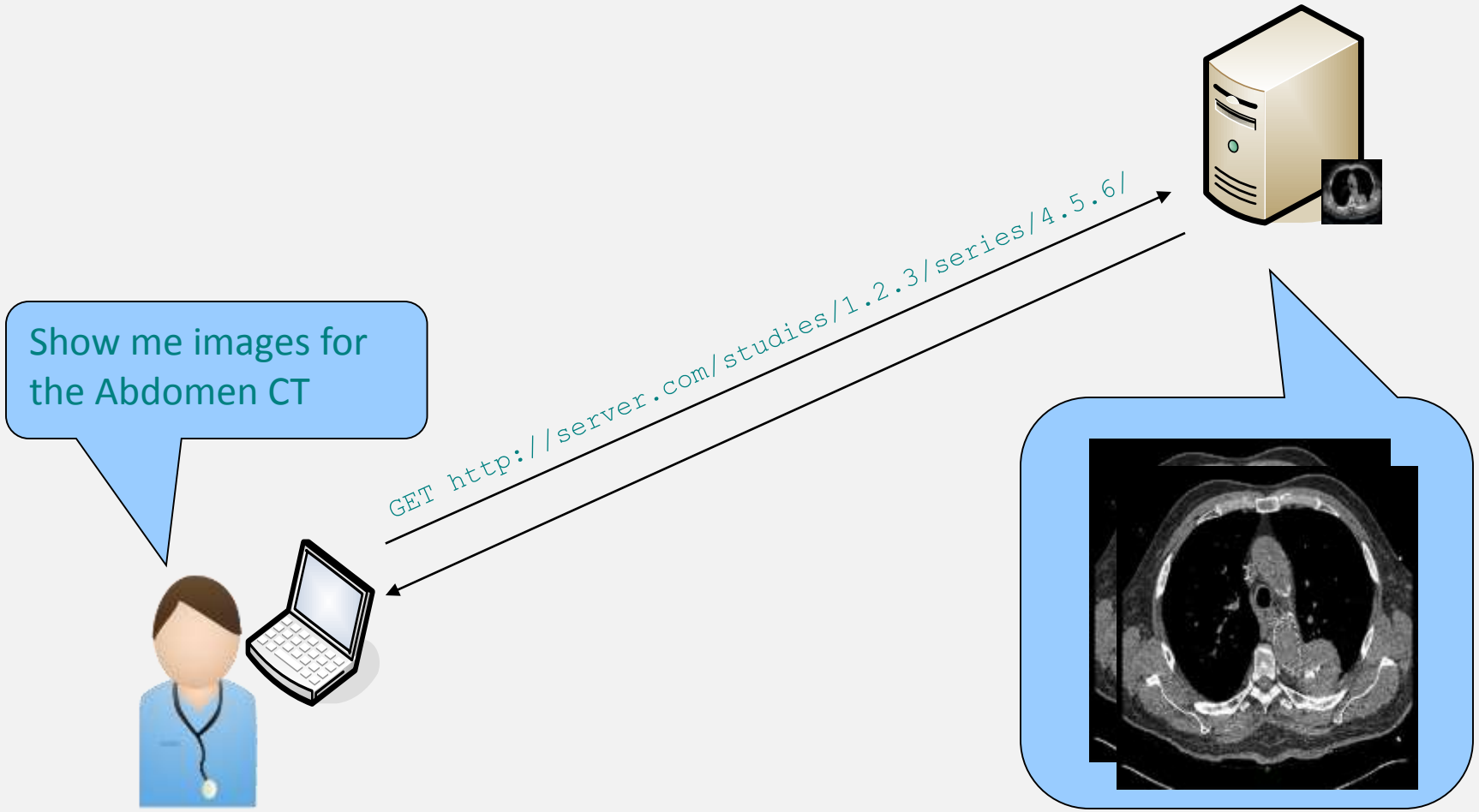
Query	• **QIDO-RS (Query based on ID for DICOM Objects)** • DICOM PS3.18 6.7
Retrieve	• **WADO-RS (Web Access of DICOM Objects)** • DICOM PS3.18 6.5
Store	• **STOW-RS (Store over the web)** • DICOM PS3.18 6.6
Tasks	• **UPS-RS (Worklist Service)** • DICOM PS3.18 6.9
Server Info	• **Capabilities Service** • DICOM PS3.18 6.8

Query (QIDO-RS) Example

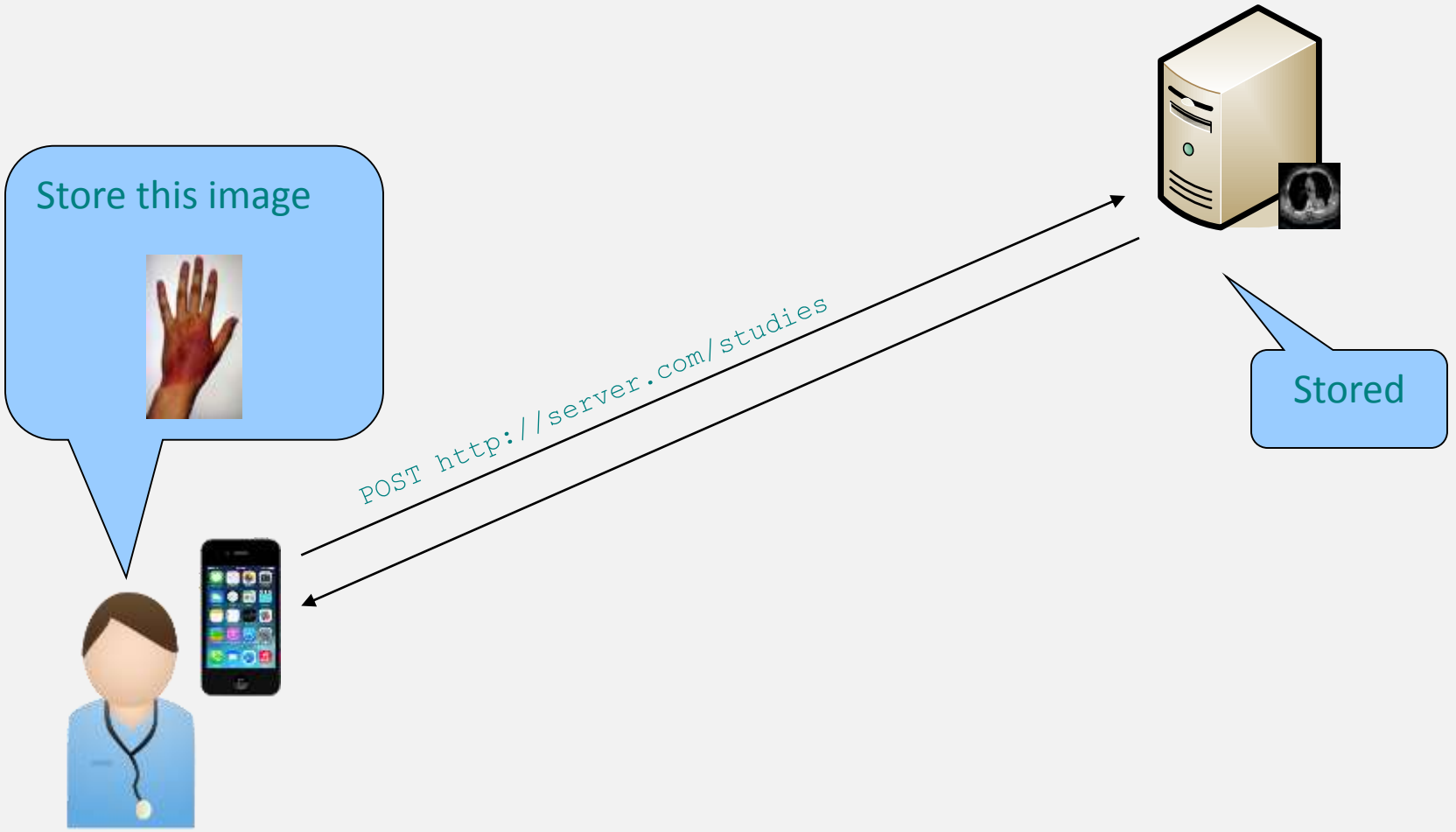


* There is synergy here with FHIR ImagingStudy

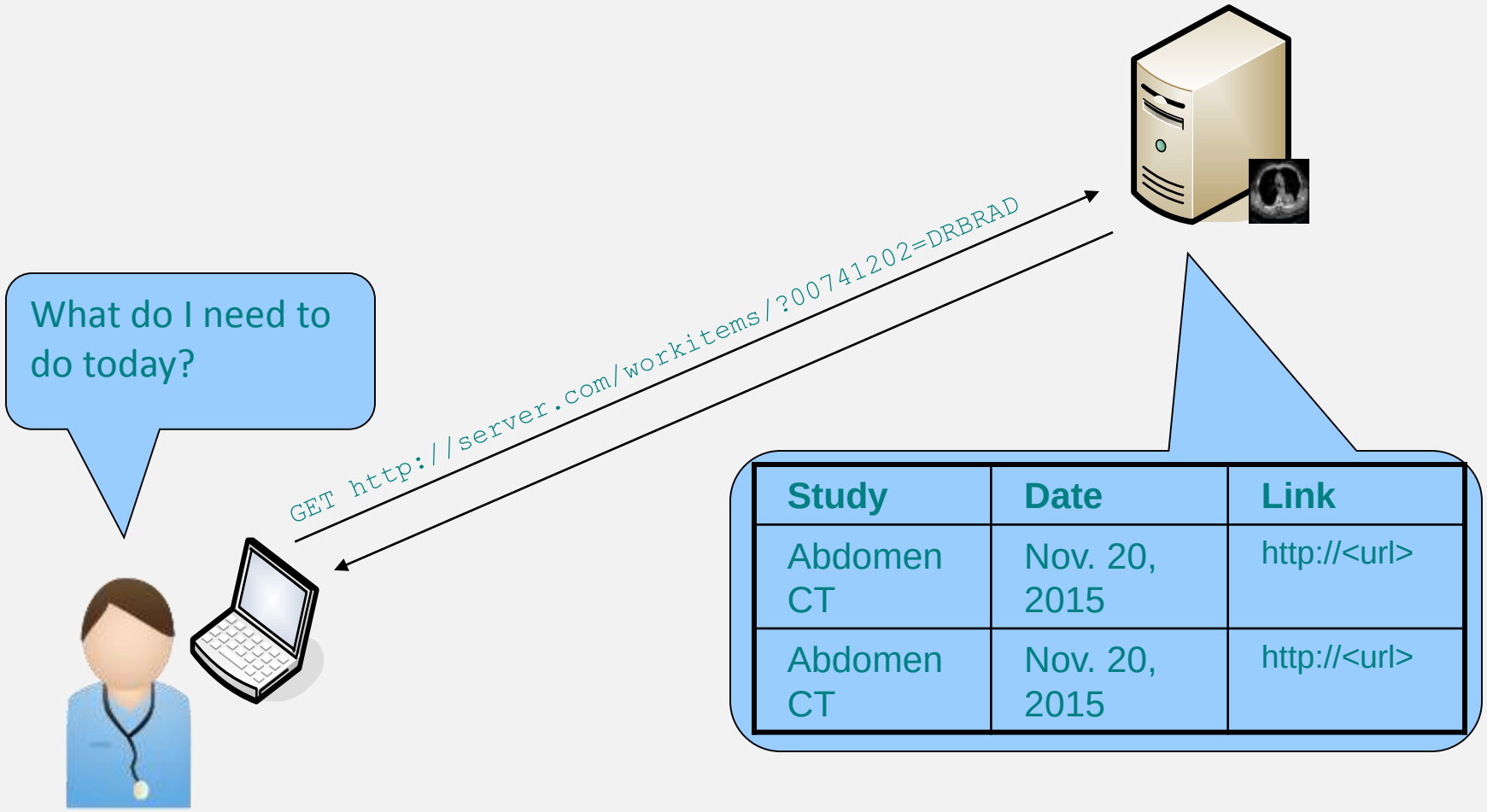
Retrieve (WADO-RS) Example



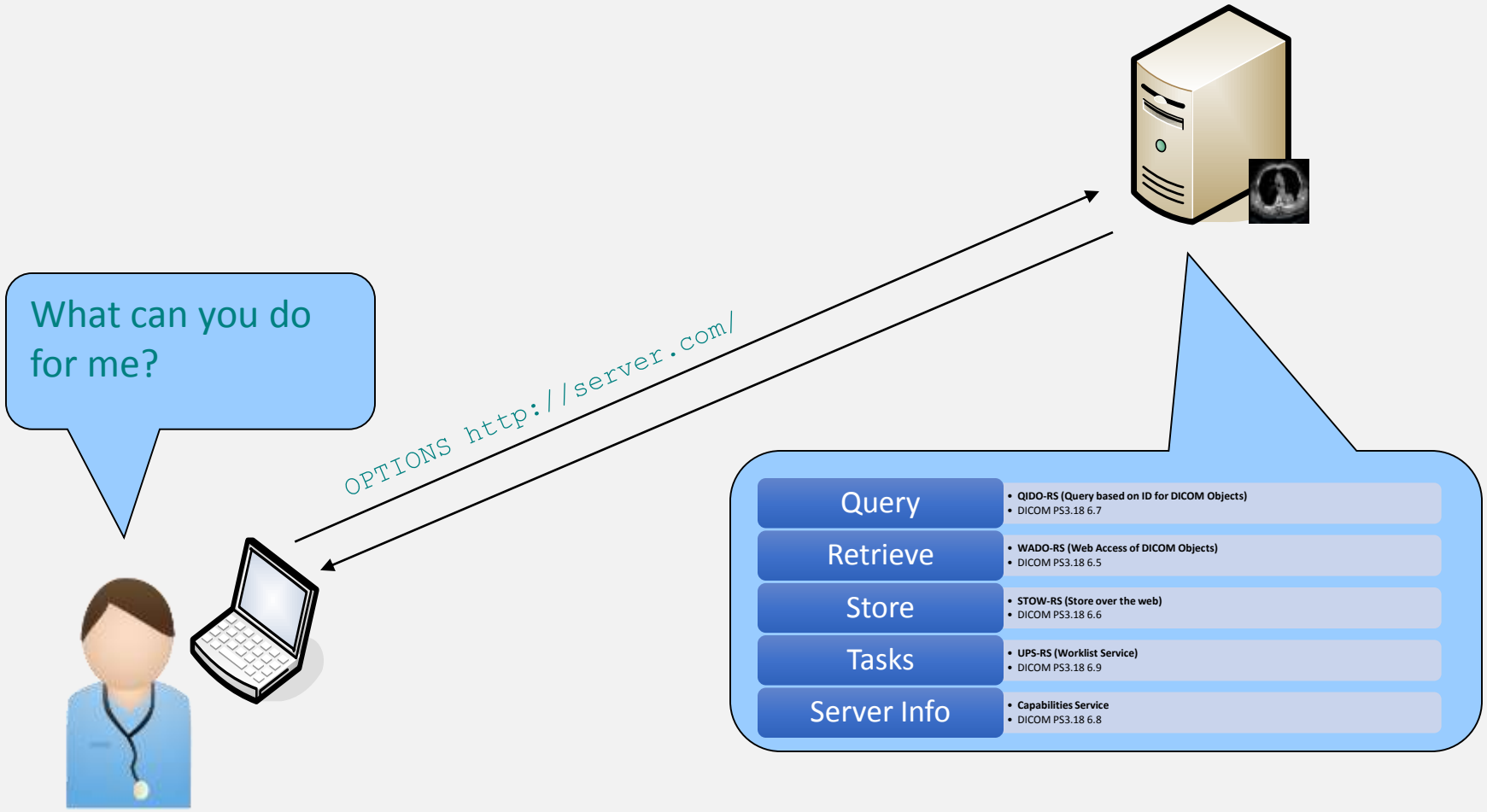
Store (STOW-RS) Example



Tasks (UPS-RS) Example



Capabilities Example



* There is synergy here with FHIR's Conformance

DICOMweb™ Cheatsheet

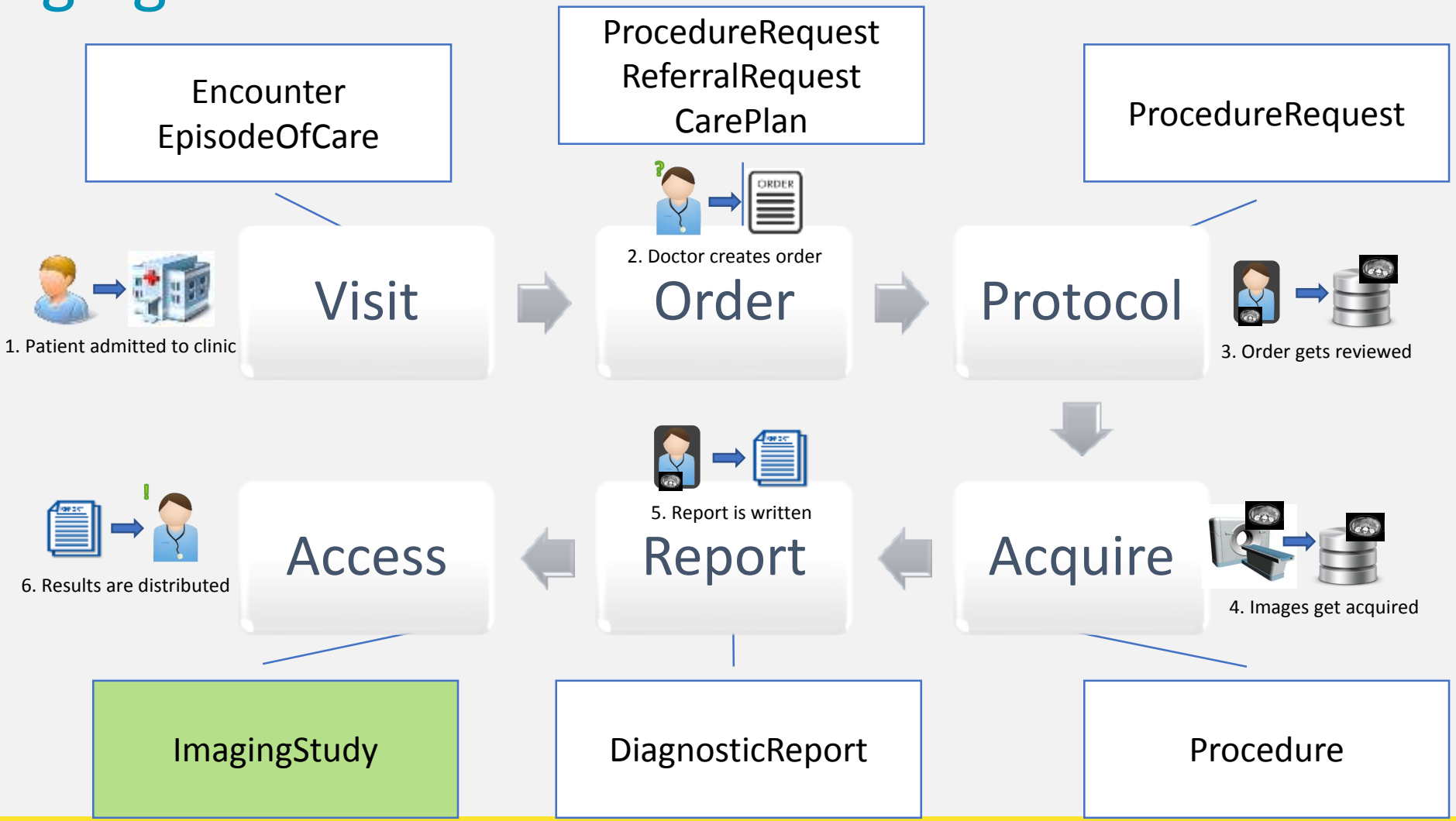
Verb	Path	Type	Description
POST	{s}/studies	Store PS3.18 6.6.1	Store instances
GET	{s}/studies?...	Query PS3.18 6.7.1	Query for matching studies
GET	{s}/studies/{studyUID}	Retrieve PS3.18 6.5.1	Retrieve entire study
POST	{s}/studies/{studyUID}	Store PS3.18 6.6.1	Store instances
GET	{s}/studies/{studyUID}/metadata	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

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

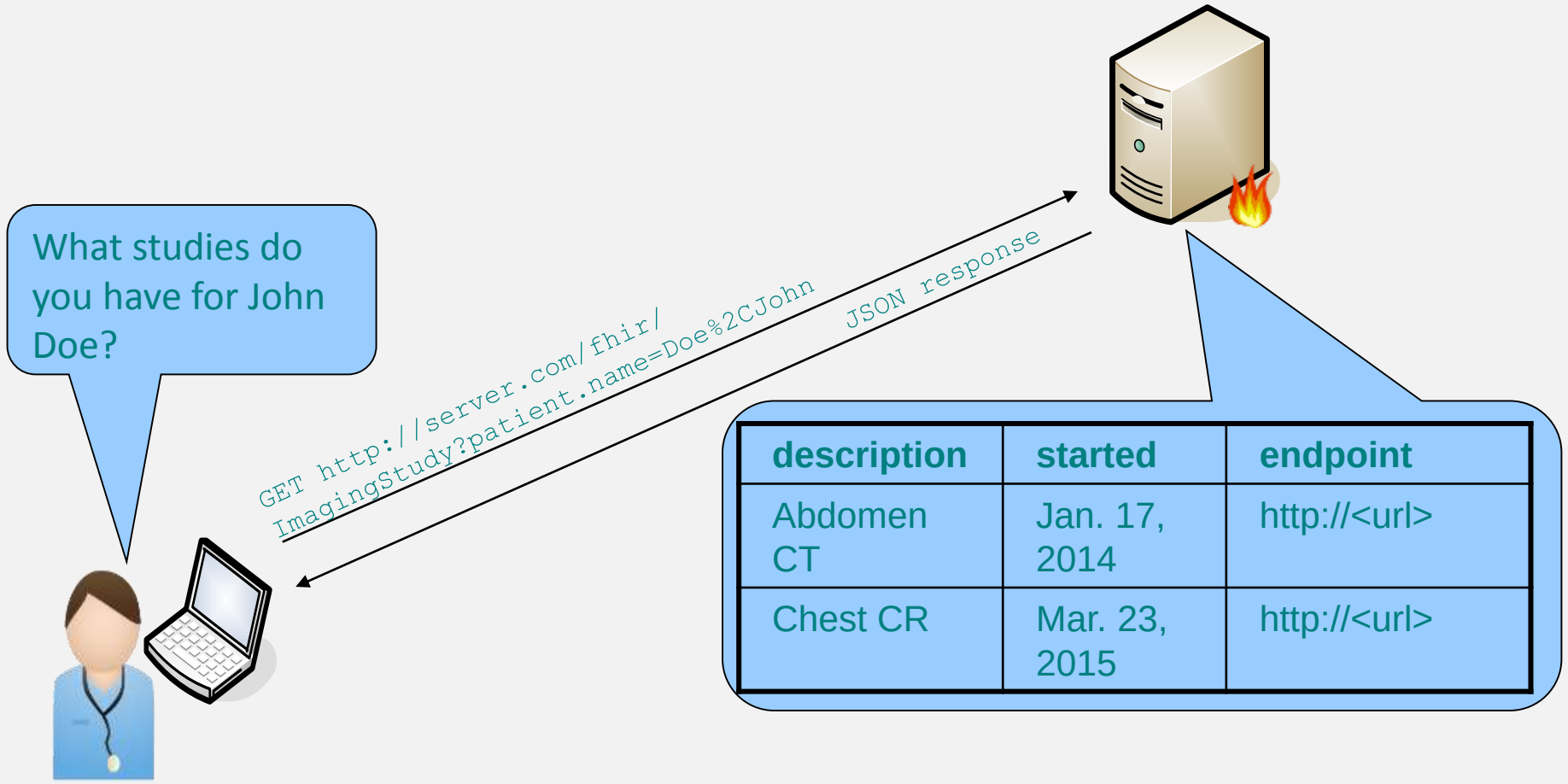
Available at:
http://dicomweb.org/DICOMweb-Cheatsheet.pdf

MARRYING FHIR & DICOMWEB

Imaging Workflow on FHIR



ImagingStudy Example



ImagingStudy Result Snippet

Not a complete example

```
{"resourceType": "ImagingStudy",
 "id": "example",
 "uid": "urn:oid:2.16.124.113543",
 "patient": {"reference": "Patient/12345"},
 "started": "2011-01-01T11:01:20+03:00",
 "endpoint" : [
     {"connectionType":"dicom-wado-rs", "address":"https://server.com/wado"}],
 "series": [ {
     "uid": "urn:oid:2.16.124.113543.2",
     "number": 3,
     "endpoint" : [
        {"connectionType":"dicom-wado-rs", "address":"https://server.com/wado"}],
     "modality": {
          "system": "http://dicom.nema.org/resources/
                        ontology/DCM",
          "code": "CT"
     },
    "description": "CT Surview 180",
    "bodySite": {
        "system": "http://snomed.info/sct",
        "code": "67734004",
        "display": "Upper Trunk Structure"
     },
    "instance": [ {
        "uid": "urn:oid:2.16.124.113543.2.3",  "number": 1,
        "sopClass": "urn:oid:1.2.840.10008.5.1.4.1.1.2"
} ] } ] }
```

Hands-on

- Find Patient via FHIR
- Find ImagingStudy via FHIR
- Discover study structure via QIDO-RS
- Retrieve Image/DICOM binary file via WADO-RS

- Bonus:
  - Searching through DICOMweb
  - Bulk Retrieval of an entire study

Thank you! Questions?

- Reach out!
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