DICOMweb™

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A time of change for healthcare

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Digital Imaging and Communications in Medicine

Patient-centered care requires:

- Access to data from multiple institutions, anywhere
- Consistent access to all types of data, including images

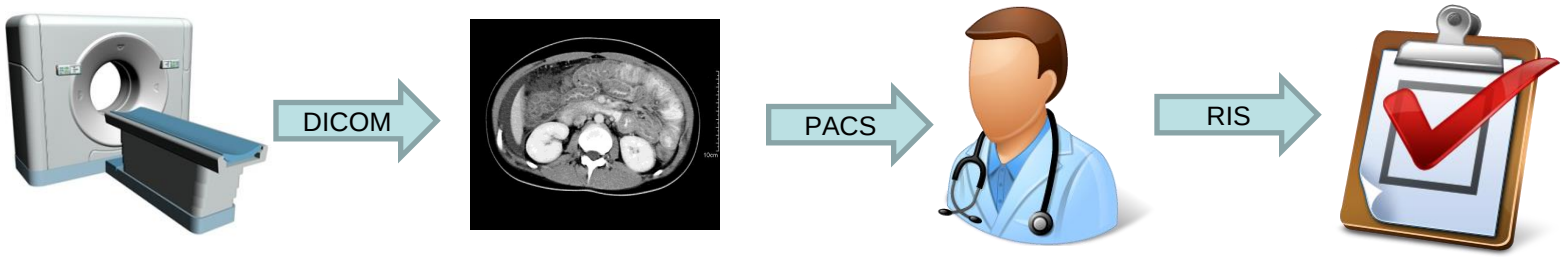
Mobile technology changes access methods

- Smart phones / tablets, not fixed workstations
- Web services for data distribution

Applications ecosystem breaks system models

- Cloud based apps from multiple vendors
- Dynamic configuration

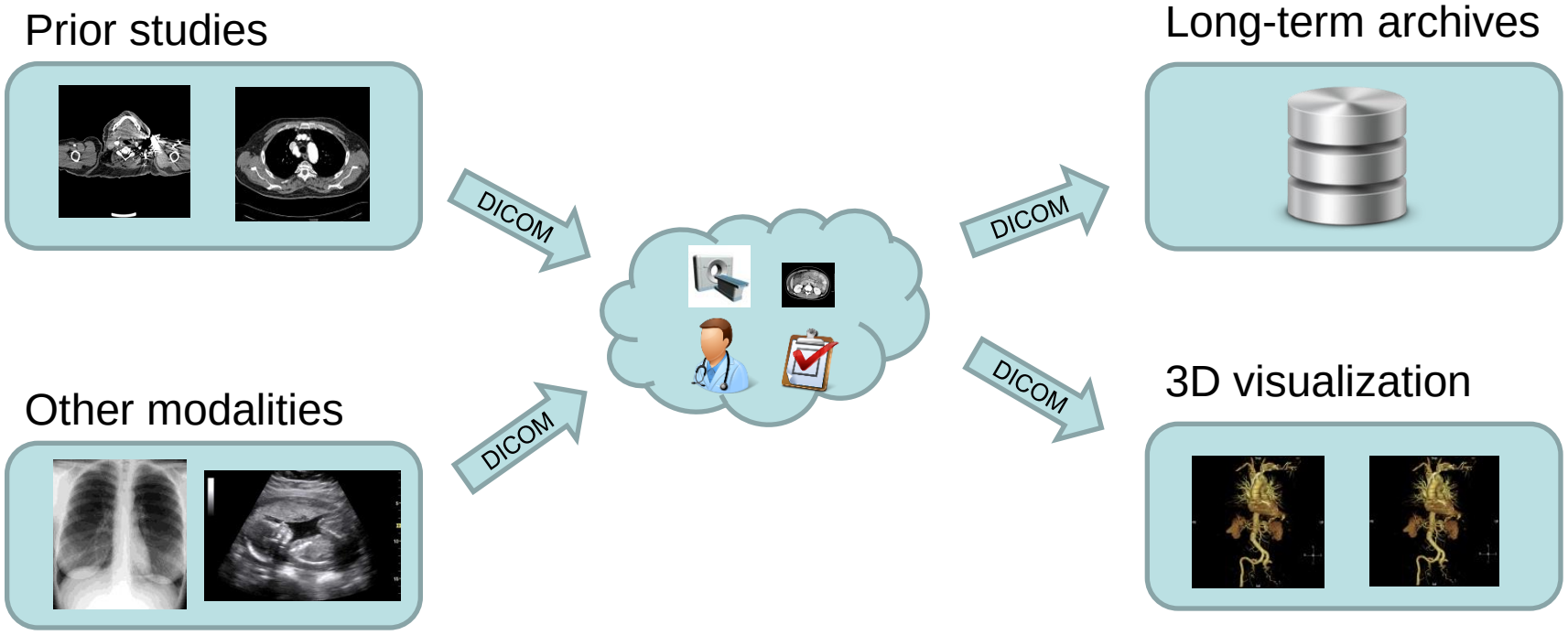
Classical Image Lifecycle



Task	User	Location	Application
Acquire Images	Technologist	In hospital	Modality
QA Images	Technologist / PACS Admin	In hospital	PACS
Read Images	Radiologist	In hospital	PACS / multi-monitor workstation

… but that's not all!

Extended Image Lifecycle



… but that's not all!

Evolving Image Lifecycle

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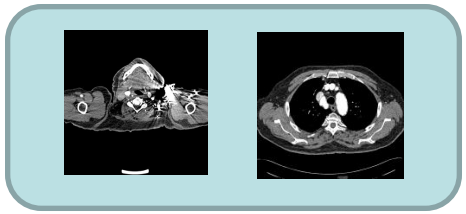
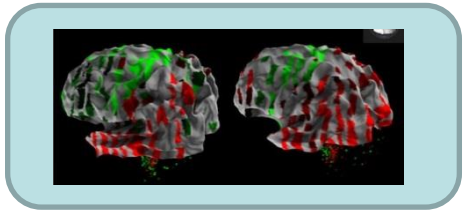
Foreign studies



Research analytics



Non-DICOM modalities

???

???

???

???

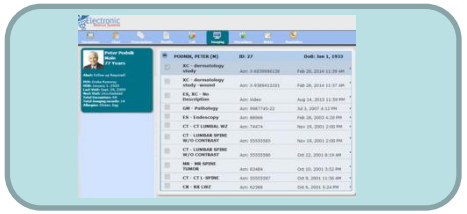
???

???

Sharing Portals

Regional archives

Medical Records



Mobile Devices

Problems in a Global Space

Dynamic Environment

- How do we manage changing endpoints and apps on demand?

Network Security

- How do we encrypt in transit?
- How do we authenticate and authorize?

Network Performance

- How do we negotiate protocols fast?
- How do we deal with low bandwidth and high latency connections?

Understanding DICOM

- How do we cross the big gap for non-medical imaging solutions?

It may be new to medical imaging …

… but it is not new to the Internet economy

How are these problems handled today outside of medical imaging?

- By the Web services ecosystem

HTTP Internet Data Transfer

- **HTTP/1.1 is ubiquitous; readily available tools that form the foundation for data communication in the modern world**
- **Request/response protocol in the client/server computing model**
- **Can be streamed, multi-threaded**
- **Can resume after interruption**
- **Caching, authentication, and authorization all part of HTTP or related standards**

RESTful Web Services

REpresentational State Transfer - architectural style for standardizing data and workflow operations over HTTP

Scalable, fault-tolerant, recoverable, secure, and loosely-coupled

Resources – smallest data units of transactions

Standard HTTP verbs – operations on resources

- **GET - retrieve a resource**
- **POST - create a new resource**
- **PUT - update an existing resource**
- **DELETE - remove a resource**

Standard HTTP headers, status codes, security

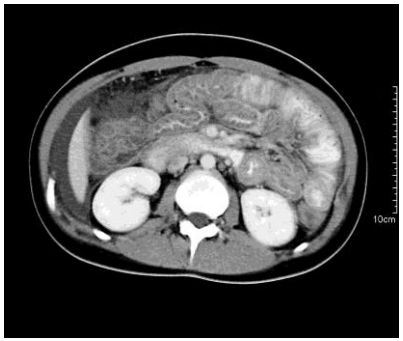
Resources

Resource	Returns
/patients	A list of all patients
/patients/bob	Details about “Bob”
/patients/bob/reports	A list of all Bob’s reports
/patients/bob/reports/1	Details about Bob’s first report

Verbs + Resources

Verb	Results
GET /patients/bob/reports/1	Returns details about Bob's first report
POST /patients/bob/reports/1	Creates a new report with an ID of 1
PUT /patients/bob/reports/1	Updates report ID 1 with new information
DELETE /patients/bob/reports/1	Deletes report 1
OPTIONS /patients	Returns capabilities for actions on patients

Back to Medical Imaging



Strategic Goals of DICOM

Extend medical imaging to a wider audience by leveraging cross-industry web protocols and web developer training

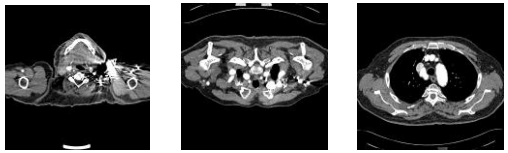
Maintain the investment in systems and image data by incremental capability enhancement, not wholesale replacement

Keep aligned with other healthcare web service developments (FHIR)

Medical Imaging Metadata

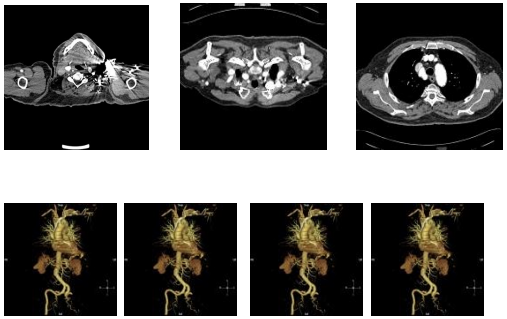
Instance

- Instance UID
- Height
- Width
- Position



Series

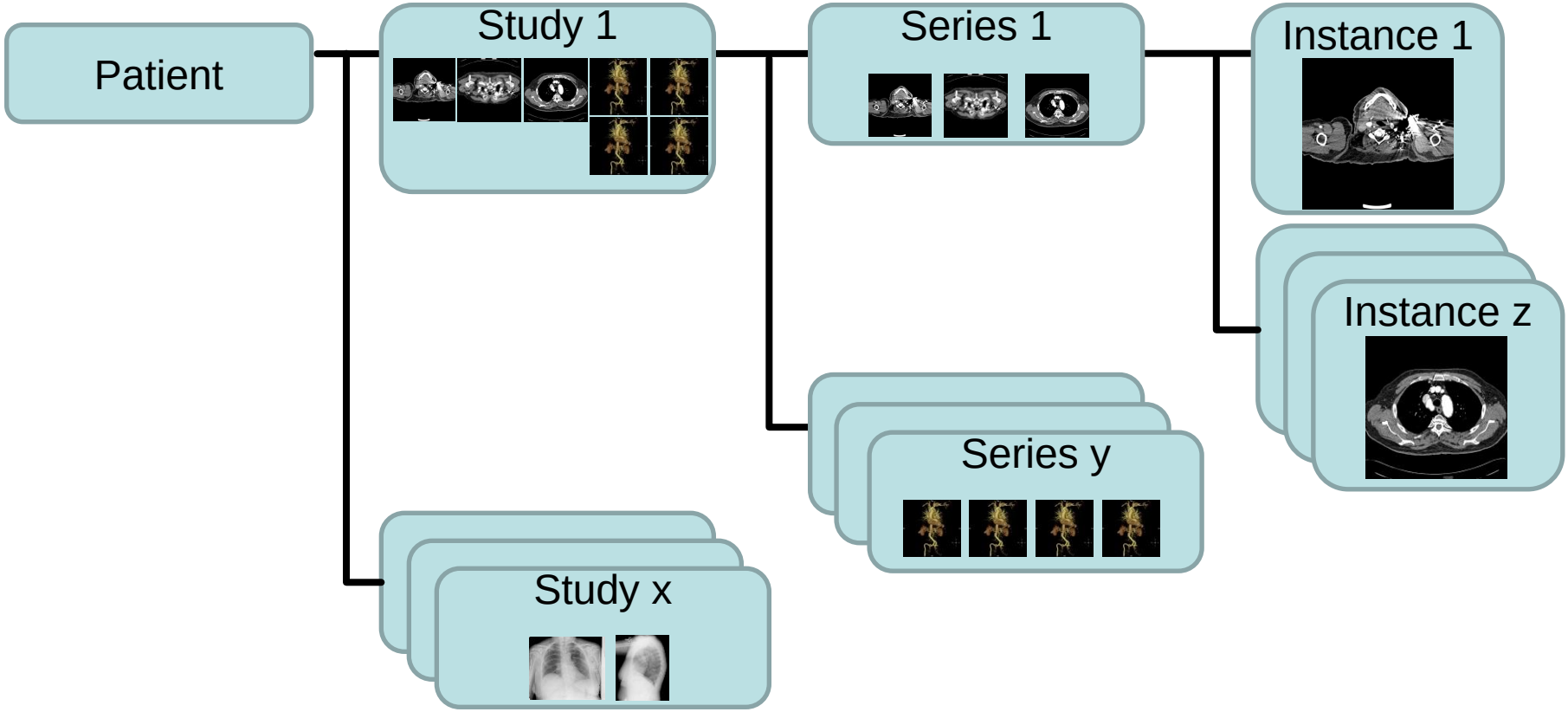
- Series UID
- Modality
- Description
- Series Number
- Body Part



Study

- Study UID
- Date of Study
- Description
- Refer Physician
- Accession
- Availability

Medical Imaging Hierarchy



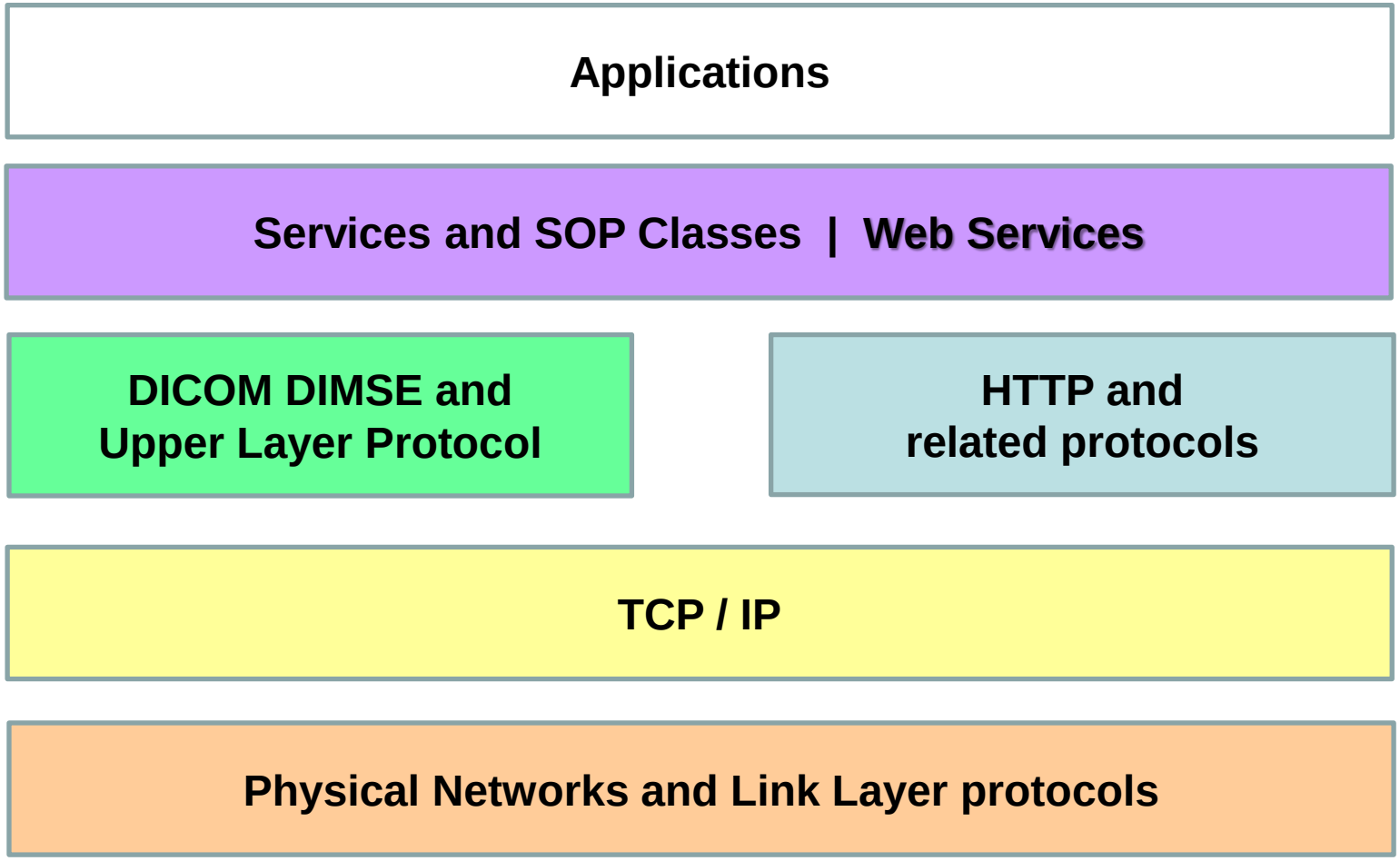
Each patient has x studies, which has y series,

which has z instances. … and could have f frames.

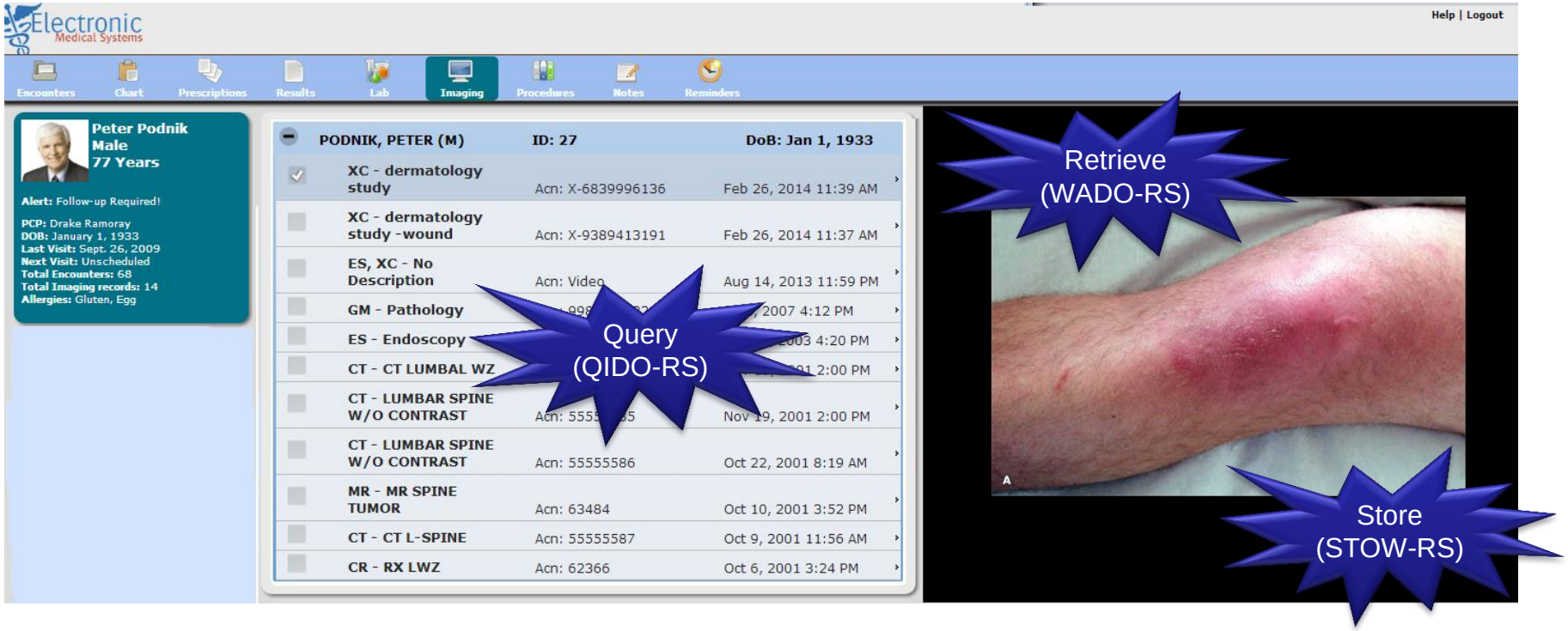
Introducing DICOMweb™

- **Web standard for medical imaging**
- **Covers basic imaging interactions**
  - **Storing via STOW-RS**
  - **Query via QIDO-RS**
  - **Retrieval via WADO (-RS, -URI, -WS)**
  - **Workflow via UPS-RS**

Protocol Stacks for DICOM



DICOMweb™ in practice



Plugs into Web Infrastructure

User (clinician)

Client (browser)

DICOMweb™ APIs

Security

Web Platform (.Net, J2EE)

Backend Infrastructure (DICOM)

Server

Compatible with DICOM

Service	DICOM DIMSE	DICOMweb	Definition
Query	C-FIND	QIDO-RS	Query by IDs for DICOM Objects using RESTful Services
Retrieve	C-MOVE C-GET	WADO-RS	Web Access to DICOM Objects using RESTful Services
		WADO-WS	Web Access to DICOM Objects using WS-* Services (SOAP)
		WADO-URI	Web Access to DICOM Objects using URI
Storage	C-STORE	STOW-RS	Store Over the Web using RESTful Services
Unified Procedure Step	N-CREATE N-SET N-GET C-FIND N-ACTION N-EVENT REPORT	UPS-RS	Unified Procedure Step using RESTful Services

Web-friendly Structures

```
<DicomAttribute Tag="00080020" VR="DT" Keyword="StudyDate">
    <Value number="1">20130409</value>
</DicomAttribute>
<DicomAttribute Tag="00080061" VR="CS" Keyword="ModalitiesInStudy">
    <Value number="1">CT</value>
</DicomAttribute>
<DicomAttribute Tag="00100010" VR="PN" Keyword="PatientName">
    <PersonName number="1">
        <AlphabeticName>
            <FamilyName>Doe</FamilyName>
            <GivenName>John</GivenName>
         </AlphabeticName>
    </PersonName>
</DicomAttribute>
<DicomAttribute Tag="0020000D" VR="UI" Keyword="StudyInstanceUID">
    <Value number="1">
        1.2.392.200036.9116.2.2.2.1762893313.1029997326.945873
    </Value>
</DicomAttribute>
```

XML

Web-friendly Structures


```
"00080020": {
    "vr": "DT", "Value": ["20130409"]
},
"00080061": {
    "vr": "CS", "Value": ["CT"]
},
"00100010": {
    "vr": "PN", "Value": [ {
        "AlphabeticName": {
            "FamilyName": ["Doe"], "Given": ["John"]
        }
    }]
},
"0020000D": {
    "vr": "UI", "Value": [
            "1.2.392.200036.9116.2.2.2.1762893313.1029997326.945873"
    ]
}
```

JSON

Discovery via QIDO-RS

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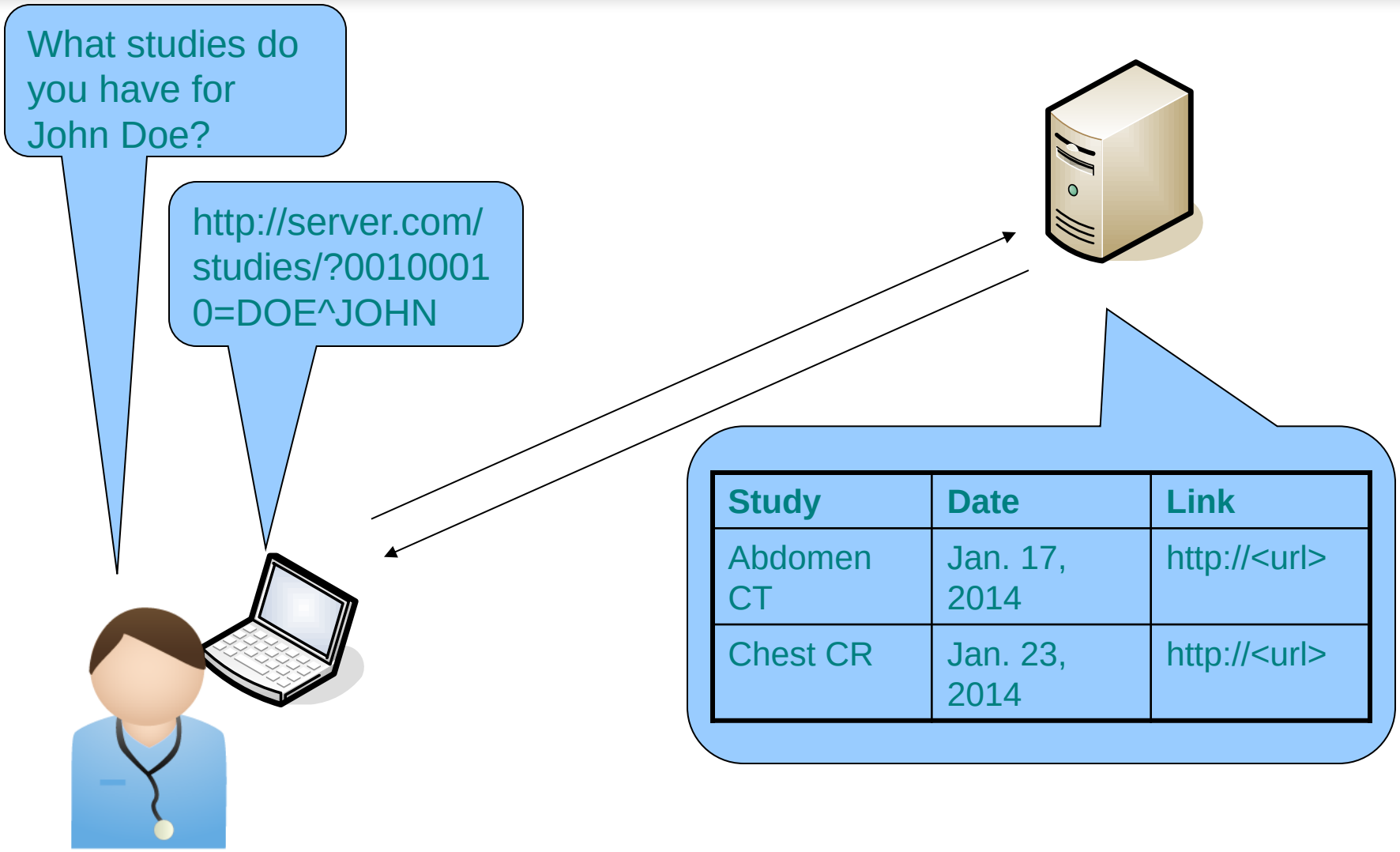
Query by IDs for DICOM Objects using RESTful Services

GET	/studies?...	Look up studies (i.e., for a particular patient)
GET	/studies/{studyUID}/series?...	Look up series in a study
GET	/series?...	Look up series (i.e., for a particular patient)
GET	/studies/{studyUID}/series/{seriesUID}/instances?...	Look up instances for a study/series
GET	/studies/{studyUID}/instances?...	Look up instances by study
GET	/instances?...	Look up instances

QIDO-RS Example



Retrieve via WADO-RS

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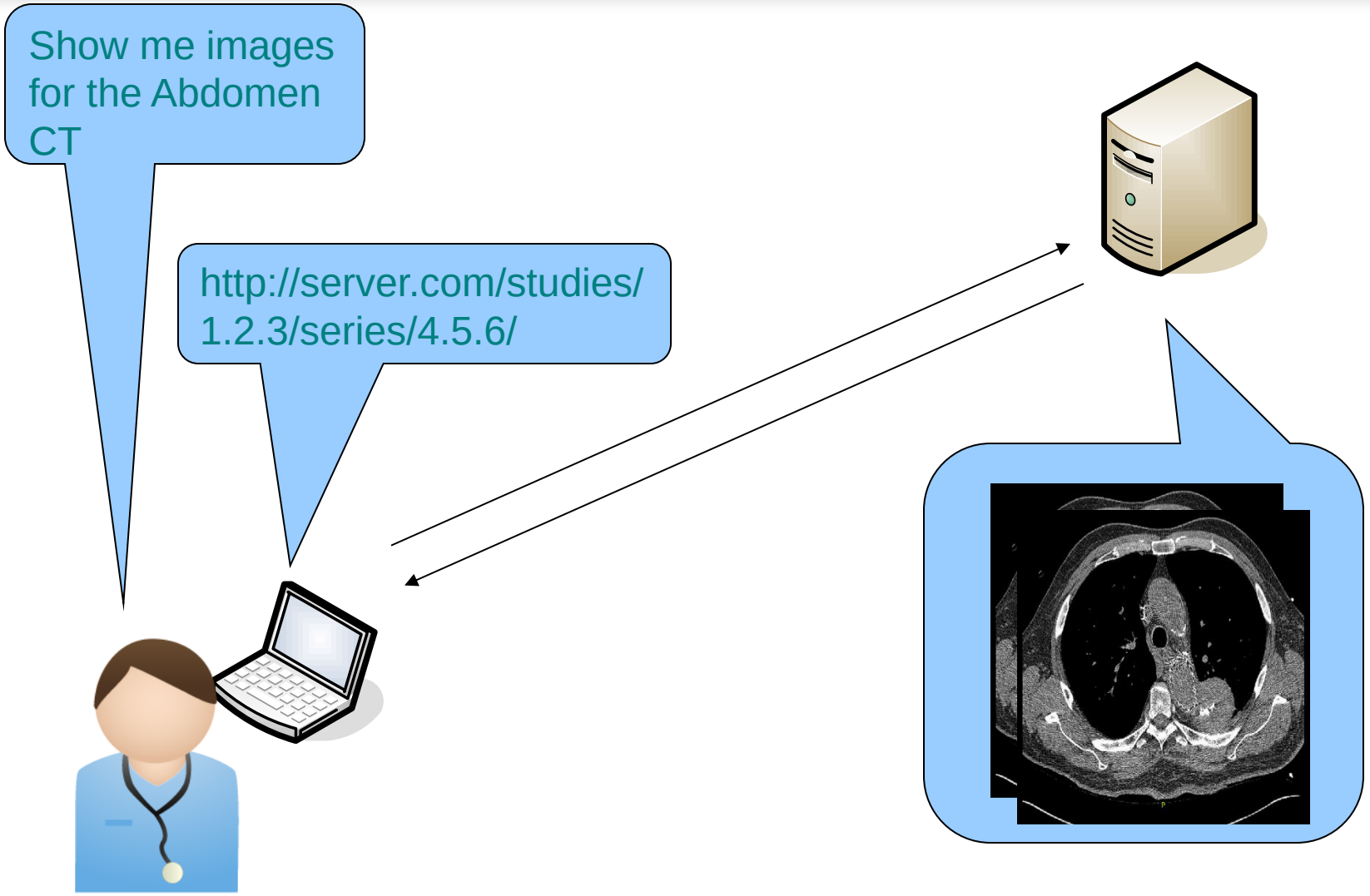
Web Access to DICOM Objects using RESTful Services

GET	/studies/{StUID}	Retrieve an individual study
GET	/studies/{StUID}/series/{SeUID}	Retrieve an individual series
GET	/studies/{StUID}/series/{SeUID}/instances/{InUID}	Retrieve an individual instance
GET	/studies/{StUID}/series/{SeUID}/instances/{InUID}/frames/{FrameList}	Retrieve individual frames
GET	/studies/{StUID}/metadata	Retrieve study meta-data
GET	{BulkDataURL}	Retrieve bulk data items

WADO-RS Example



Upload with STOW-RS

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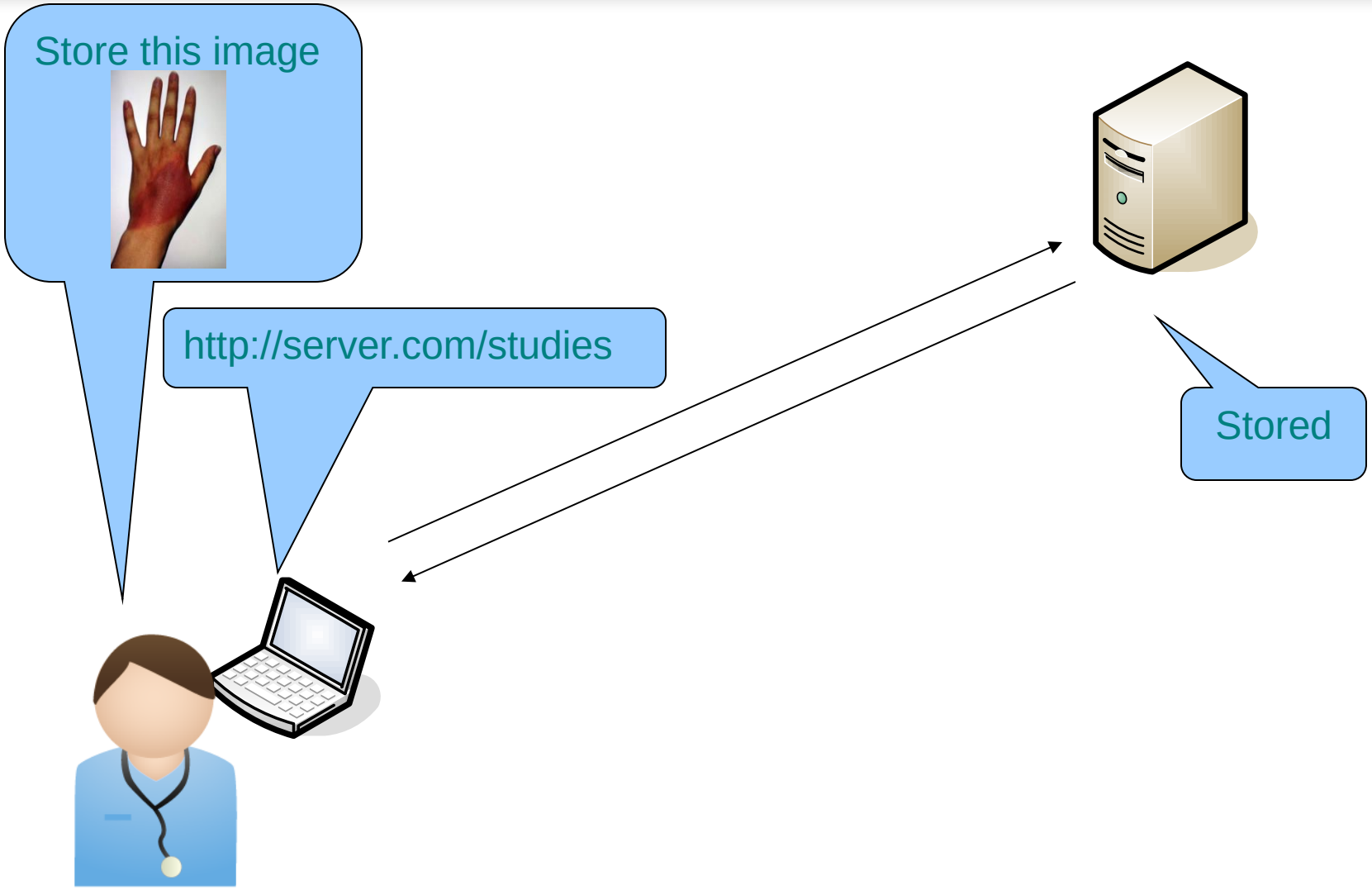
Store Over the Web using RESTful Services

POST	/studies/{StUID}	Stores a set of instances
POST	/studies/	Stores a set of instances

STOW-RS Example



WADO-URI

- **Web Access to DICOM Objects using URIs**
- **Similar to WADO-RS, but with one resource and all URI parameters**
  - http://server.com/wado/?requestType=WADO&studyUID=1.2.1.2&seriesUID=1.3.1.1&objectUID=1.4.1.4
- **One object at a time**
- **Supports rendering of objects in web formats, without metadata**
- **Also known as “plain” WADO**

WADO-WS

- **Web Access to DICOM Objects using WS-* Services (SOAP)**
  - **“Simple Object Access Protocol”**
  - **Different style of HTTP based protocol using XML documents as controls**
- **Used in IHE XDS-I transactions**
- **Supports rendering of objects in web formats**
- **Supports retrieve of object metadata**

Workflow via UPS-RS

Unified Procedure Step using RESTful Services

- Generalized workflow task management
- Transcoding of DIMSE-based UPS service

POST	/workitems?{ItemUID}	Create a work Item
POST	/workitems/{ItemUID}?{transactionUID}	Create a work item update transaction
GET	/workitems?...	Look up work Items
GET	/workitems/{ItemUID}	Retrieve a work item
PUT	/workitems/{ItemUID}/state	Update state of a work item
POST	/workitems/{ItemUID}/cancelrequest	Cancel a work item
POST	/workitems/{ItemUID}/subscribers/{AETitle}	Create a work item notification subscription
DELETE	/workitems/{ItemUID}/subscribers/{AETitle}	Delete a work item notification subscription
GET	/subscribers/{AETitle}	Open a Websocket channel for notifications

Capabilities Discovery via Retrieve Server Options

Returns Web Application Description Language (WADL) document

OPTIONS	/studies	Get capabilities for study level operations (search, store)
OPTIONS	/studies/{StudyUID}	Get capabilities for operations on a specific study (retrieve, store)
OPTIONS	/studies/{StudyUID}/series/{seriesUID}/metadata	Get capabilities for metadata operations on a specific series (retrieve)
OPTIONS	/instances	Get capabilities for direct operations on instances (search)
OPTIONS	/workitems	Get capabilities for work item management (search, create)
OPTIONS	/workitems/{ItemUID}/subscribers/{AETitle}	Get capabilities for a specific subscriber to a specific work item
OPTIONS	/workitems/1.2.840.10008.5.1.4.34.5/subscribers/{AETitle}	Get capabilities for a specific subscriber to global notifications

Full specification

DICOM Part 18 – Web Services

http://medical.nema.org/medical/dicom/current/output/html/part18.html

DICOM Part 19 – Application Hosting

- **XML representation of DICOM data (“Native Model”)**

http://medical.nema.org/medical/dicom/current/output/html/part19.html

Relationship to FHIR

Fast Healthcare Interoperable Resources

New standard from HL7

- Currently Draft Standard for Trial Use (DSTU)
- HL7's response to same strategic needs that drive DICOMweb™

Defines healthcare information as resources

- Suitable for access using RESTful Web Services
- E.g., Patient, DiagnosticOrder, Procedure, Practitioner

Resources aligned with DICOM

- ImagingStudy, ImagingObjectSelector
- Allow navigation and reference of DICOM resources from FHIR
- WADO-RS specified as method to access DICOM objects

In Summary

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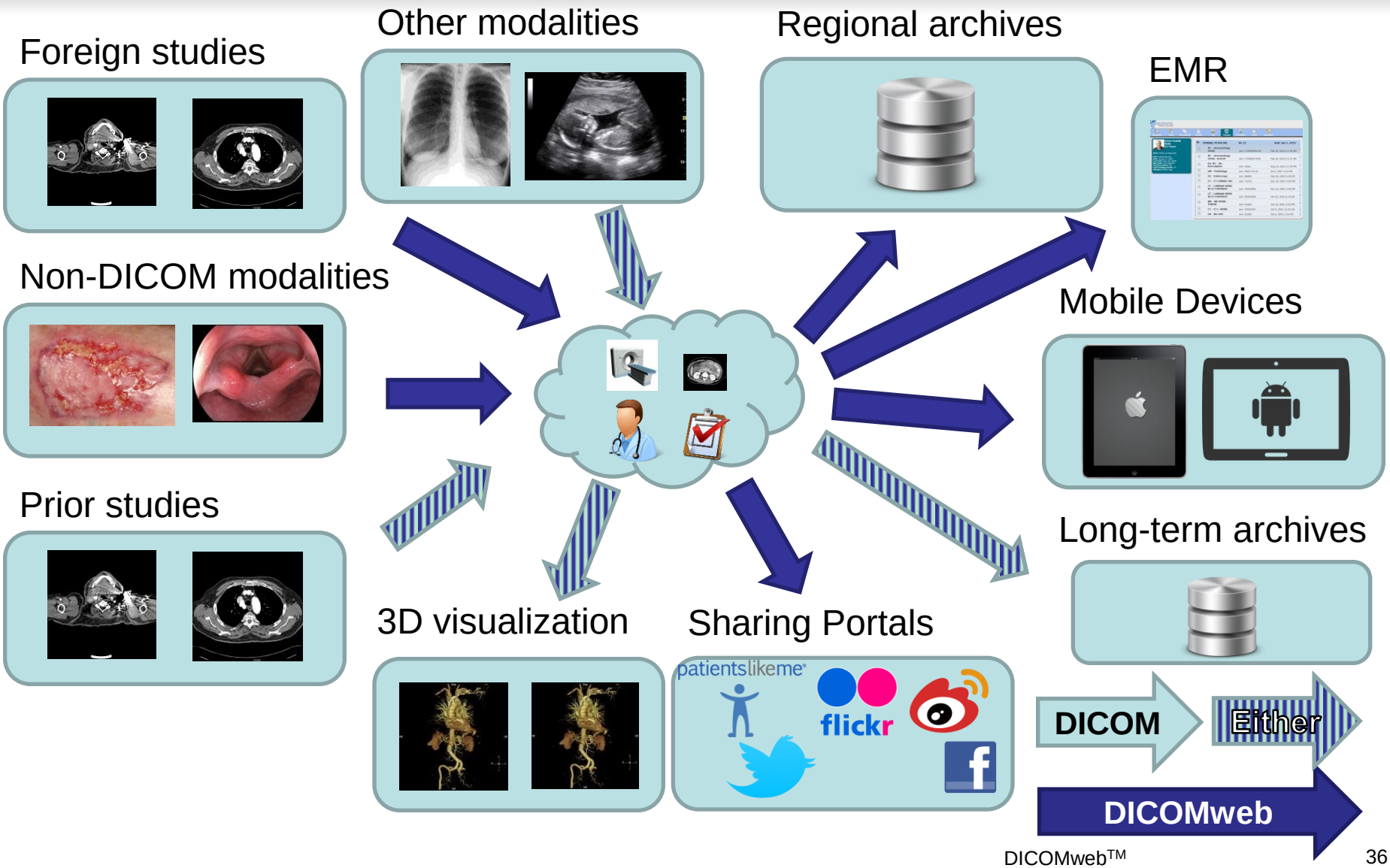

Thank You!

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Questions?