China

Chengdu

DICOMweb™

http://www.dicomweb.org/

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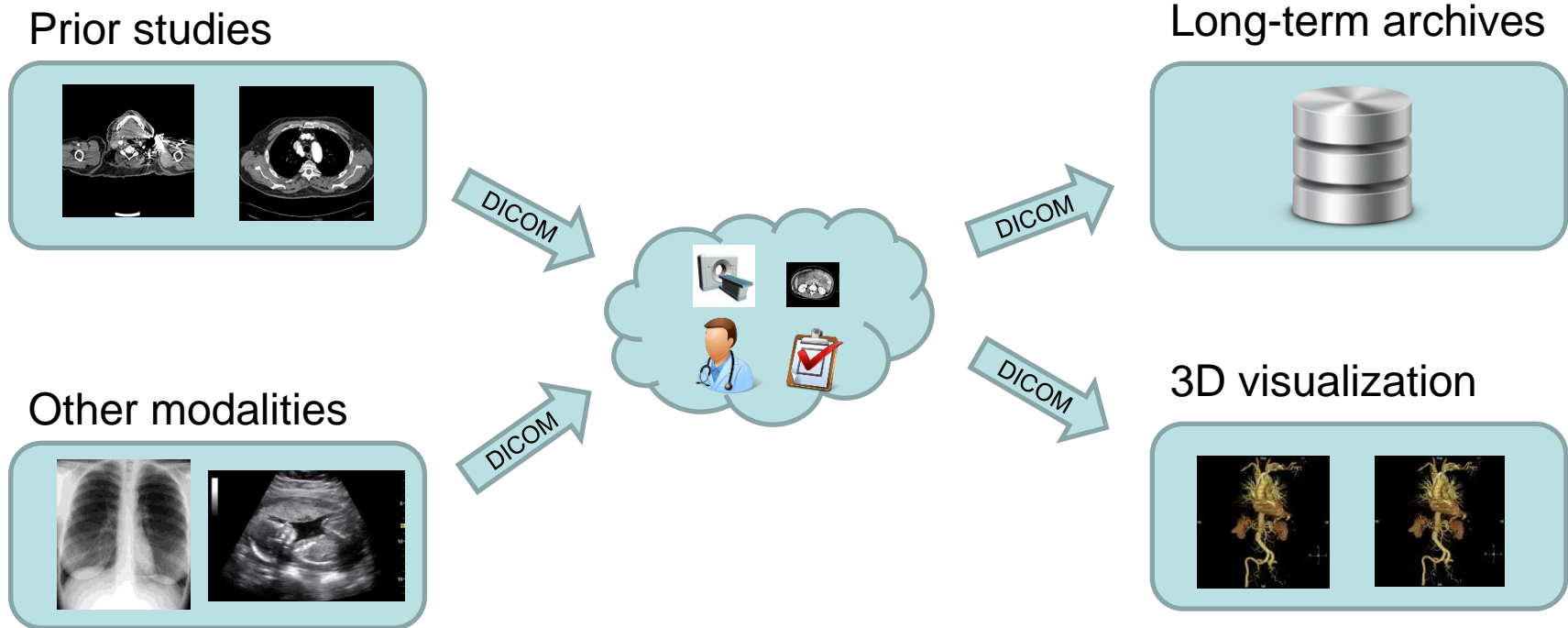
Image Lifecycle
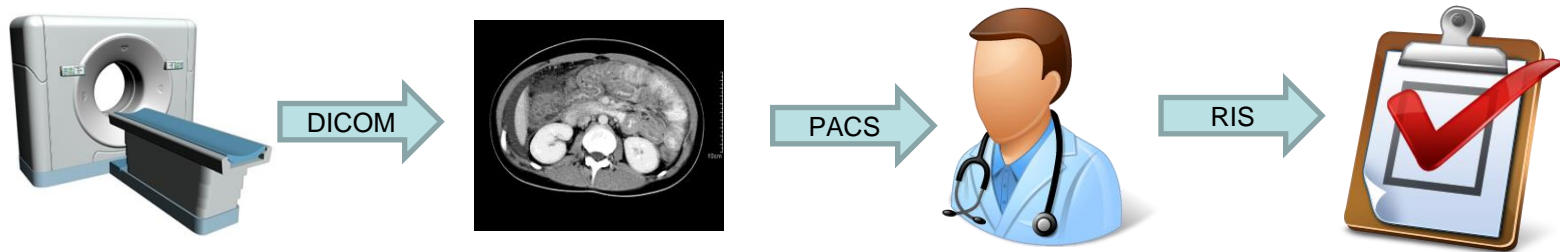
Task	User	Location	Application
Acquire Images	Technologist	In hospital	Modality
QA Images	Technologist / PACS Admin	In hospital	PACS
Read Images	Radiologist	In hospital	PACS

… but that's not all!

Extended Image Lifecycle

Prior studies

Other modalities

Long-term archives

3D visualization

DICOM

DICOM

DICOM

DICOM

… but that's not all!

Tertiary Image Lifecycle

Foreign studies

Non-DICOM modalities

Regional archives

Medical Records

Mobile Devices

Sharing Portals
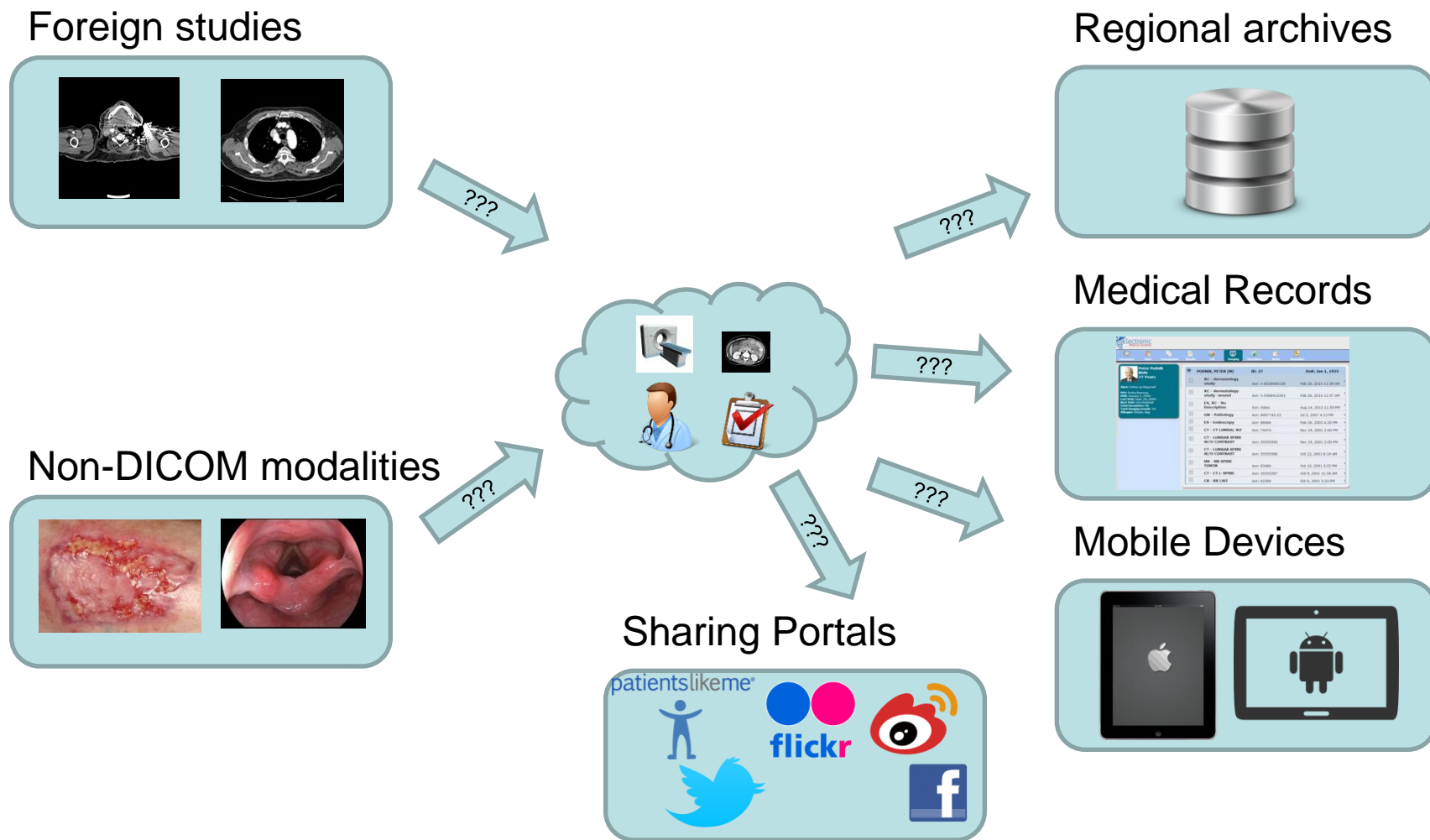
Tertiary Image Lifecycle

Task	User	Location	Application
Acquire Images	Technologist	In hospital	Modality
QA Images	Technologist / PACS Admin	In hospital	PACS
Read Images	Radiologist	In hospital	PACS
Get Prior Exams	Radiologist	In hospital, get from remote location	PACS
Review Images	Referring Physician	Remote physician office	Lightweight viewer
Review Patient Record	Attending Physician	In hospital	EMR
Physician Rounds	Care Team	In hospital and telepresence	Web Portal
Archive regionally	Technologist / PACS Admin	In hospital to remote	PACS

Tertiary Image Lifecycle

Foreign studies
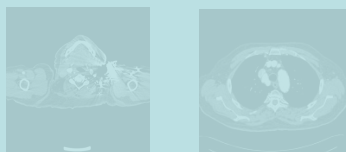
Regional archives

Network security and performance

Medical Records

Non-DICOM modalities

Does not understand DICOM

Mobile Devices

Sharing Portals

Problems in a Global Space
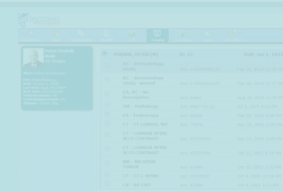
- ## Network Security
  - ### How do we encrypt in transit?
  - ### How do we authenticate and authorize?

- ## 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?

How do we do this today outside of medical imaging?

The Internet

The rise of the Hypertext Transport Protocol (HTTP) delivers an effective means to transfer images. But how?

Internet File 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 standard**
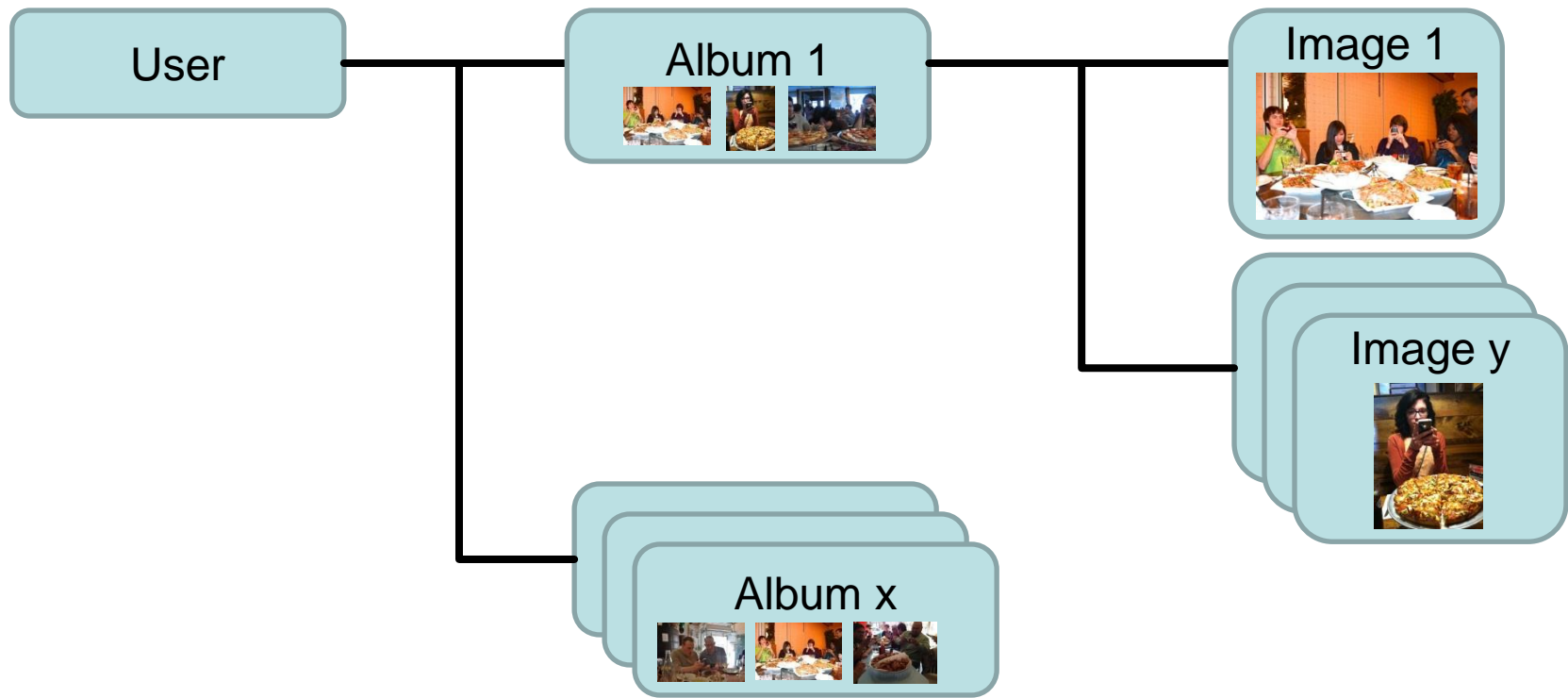
Weibo Photo Metadata

Photo

- **Height and width**
- **URL to retrieve**
- **Caption**
- **Tagged people**
- **Location**
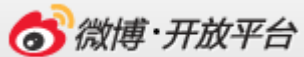- **Date and time**

Album

- **Name**
- **Collection of images**
- **Cover photo**
- **Description**
- **Privacy**
- **Place**

Weibo Image Hierarchy

Each user contains x albums, which contain y photos.

Weibo API

DICOM
Digital Imaging and Communications in Medicine

微博·开放平台   API文档/en   (http://open.weibo.com/wiki/API%E6%96%87%E6%A1%A3/en)

REST API

Timeline API

statuses/public_timeline Return the latest public weibos.
statuses/friends_timeline Return the authenticating user's and his friends' latest weibos (Alias: statues/home_timeline)
statuses/user_timeline Return the authenticating user's latest weibos.
statuses/mentions Return the authenticating user's mentions
statuses/comments_timeline Return comments of the authenticating user made and received
statuses/comments_by_me Return comments made by the authenticating user
statuses/comments_to_me Return comments the authenticating user receive
statuses/comments Return the weibo's comment list by the weibo ID
statuses/counts Return the comment counts and repost counts of a list of w
statuses/repost_timeline Return the latest of repost weibos of a original wei
statuses/repost_by_me Return the latest repost weibos of authenticating us
statuses/unread Return the authenticating user's unread weibo count
statuses/reset_count Reset unread weibo count
emotions Emotion linterface, return the emotion list

JSON Example

```
[
    {
        "created_at" : "Tue Nov 30 14:34:35 +0800 2010",
        "text" : "吃力不讨好的事情我是坚决不会再做了，RI你个仙人！发飙~~~~我只想说档次和素质在那里去了，你
也就只能在这种地方混！",
        "truncated" : false,
        "in_reply_to_status_id" : "",
        "annotations" :
        [

        ],
        "in_reply_to_screen_name" : "",
        "geo" : null,
        "user" :
        {
            "name" : "习惯寂寞吗",
            "profile_image_url" : "http://tp3.sinaimg.cn/1676792942/50/1284648784",
            "created_at" : "Wed Dec 30 00:00:00 +0800 2009",
            "province" : "51",
            "location" : "四川 成都"
        },
        "favorited" : false,
        "in_reply_to_user_id" : "",
        "id" : 3978753419,
        "source" : "<a href=\"http://t.sina.com.cn\" rel=\"nofollow\">新浪微博</a>"
    },
...
]
```

What are APIs? REST?

- **Application Programming Interface**
  - **Methods to access an application's data and workflow without using the application's user interfaces**

- **REpresentational State Transfer**
  - **An architectural style for standardizing data and workflow operations over HTTP**
  - **Scalable, fault-tolerant, recoverable, secure, and loosely-coupled**

Three Levels of REST

- **Level 1: Resources**

- **Level 2: Verbs**

- **Level 3: HATEOAS**

Level 1: 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

Level 2: Verbs

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

Level 3: HATEOAS

Hypermedia as the engine of application state

```
"ids" : [
  12345678,
  87654321,
  11223344
]
```
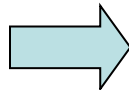
```
"links": [
    {
        "rel": "Reports",
        "href": "https://.../reports/12345678"
    },
    {
        "rel": "Appts",
        "href": "https://.../appts/87654321"
    },
    {
        "rel": "Labs",
        "href": "https://.../labs/11223344"
    }
]
```
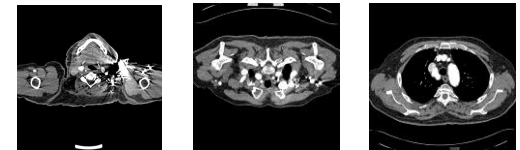
Back to Medical Imaging
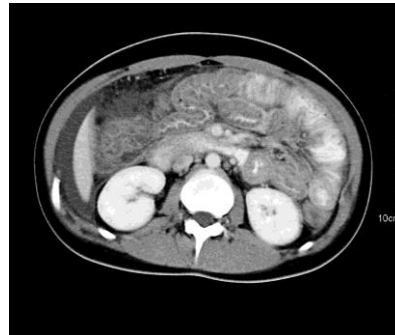
Medical Imaging Metadata
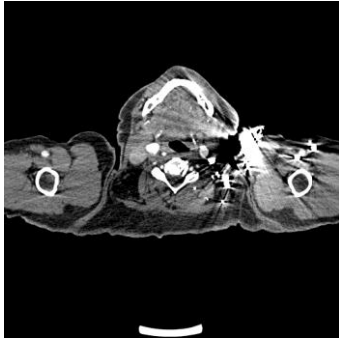
Instance

- **Instance UID**
- **Height**
- **Width**
- **Position**
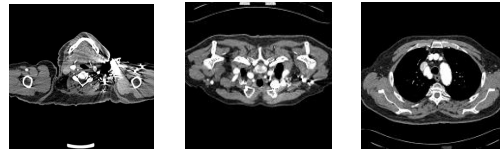
Series

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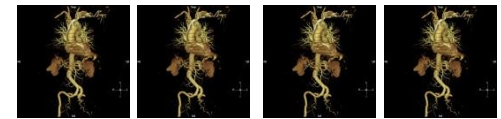
Study

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

Medical Imaging Hierarchy
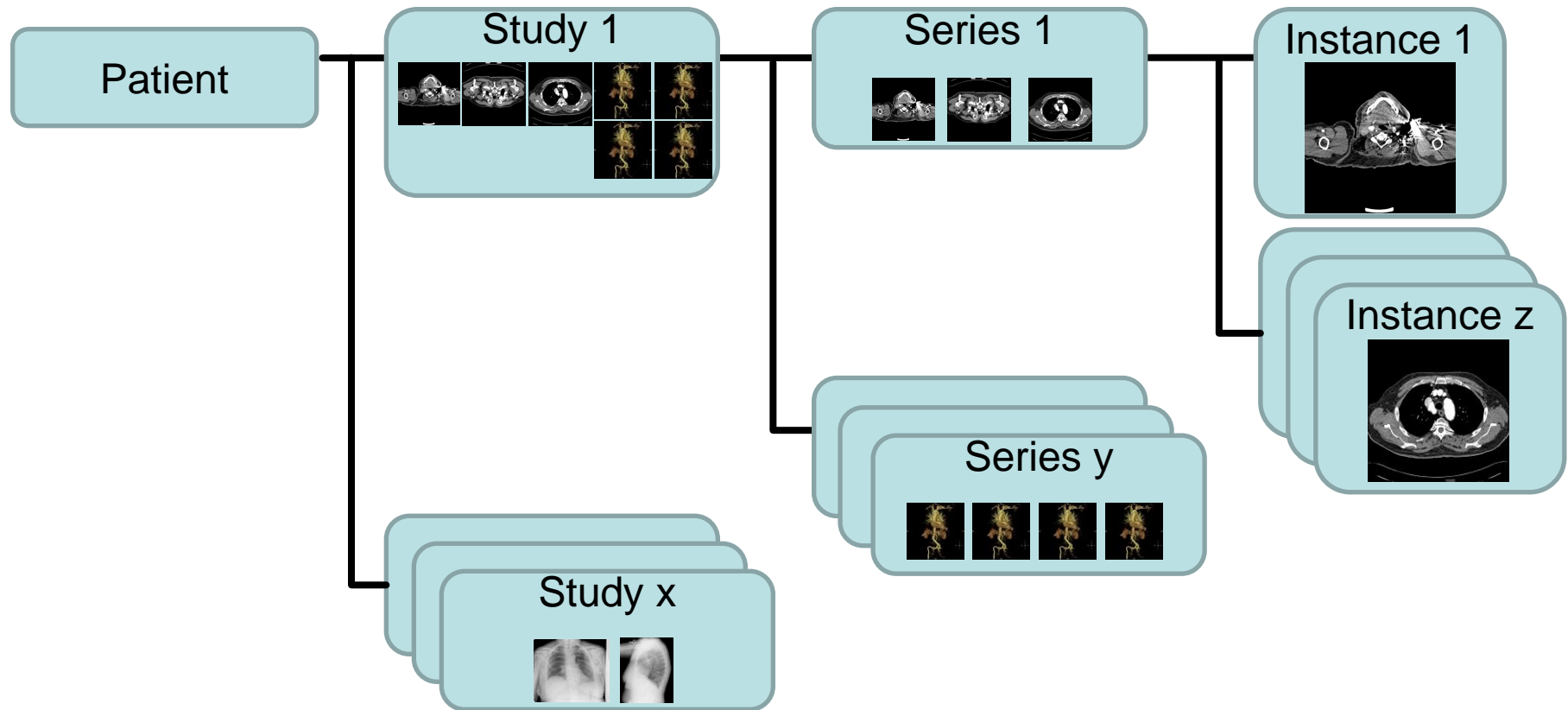
Each patient has x studies, which has y series, which has z instances.

… and could have f frames.

Introducing DICOMweb™

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

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DICOMweb™ in practice

Plugs into Web Infrastructure

DICOM — Digital Imaging and Communications in Medicine

User (clinician)

Client (browser)

DICOMweb™ APIs

Security

Web Platform (.Net, J2EE)

Backend Infrastructure (DICOM)

Server

Compatible with DICOM

Service	DICOM	DICOMweb	Definition
Query	C-FIND	QIDO-RS	Query by IDs for DICOM Objects using RESTful Services
Retrieve	C-MOVE	WADO-RS	Web Access to DICOM Objects using RESTful Services
		WADO-WS	WADO using WS-* Services (SOAP)
		WADO-URI	WADO using URI
Store	C-STORE	STOW-RS	Store via the Web using RESTful Services

Web-friendly Structures

```xml
<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">
        <SingleByte>
            <FamilyName>Doe</FamilyName>
            <GivenName>John</GivenName>
    </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": [ {
        "Alphabetic": {
            "Family": ["Doe"], "Given": ["John"]
        }
    }]
},
"0020000D": {
    "vr": "UI", "Value": [
        "1.2.392.200036.9116.2.2.2.1762893313.1029997326.945873"
    ]
}
```
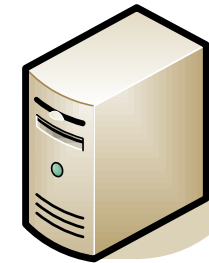
JSON

Discovery via QIDO-RS

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
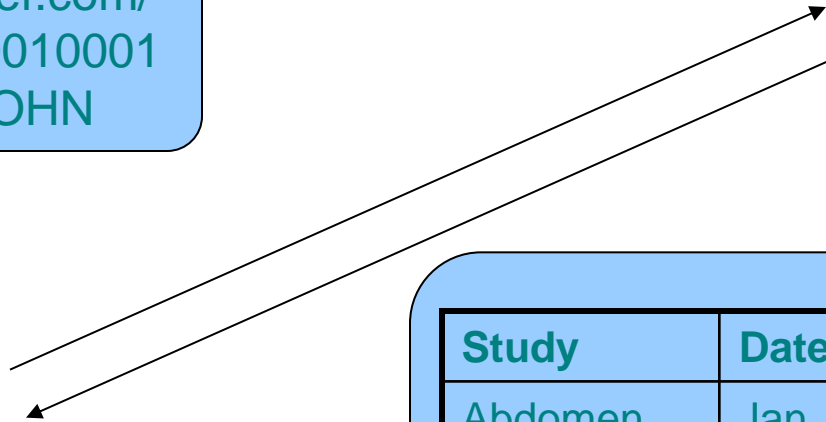
Retrieve via WADO-RS

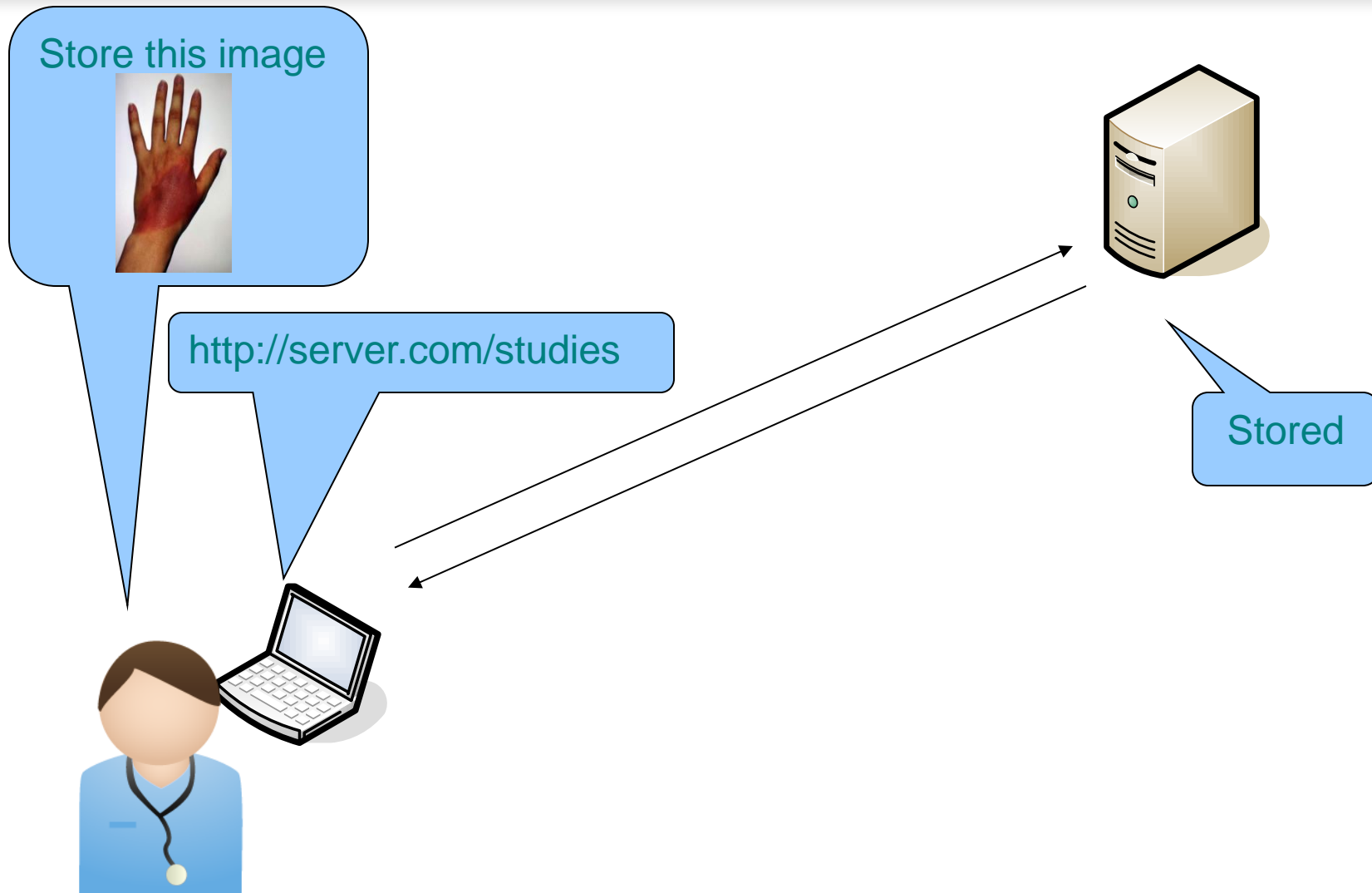| GET | /studies/{StUID} | Retrieve an individual study |
GET	/studies/{StUID}/series/{SeUID}	Retrieve an individual series
GET	/studies/{StUID}/series/{SeUID}/instances/{InUID}	Retrieve an individual instance
GET	/studies/{StUID}/series/{SeUID}/instances/{InUID}/frames/{FrameList}	Retrieve individual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

WADO-RS Example
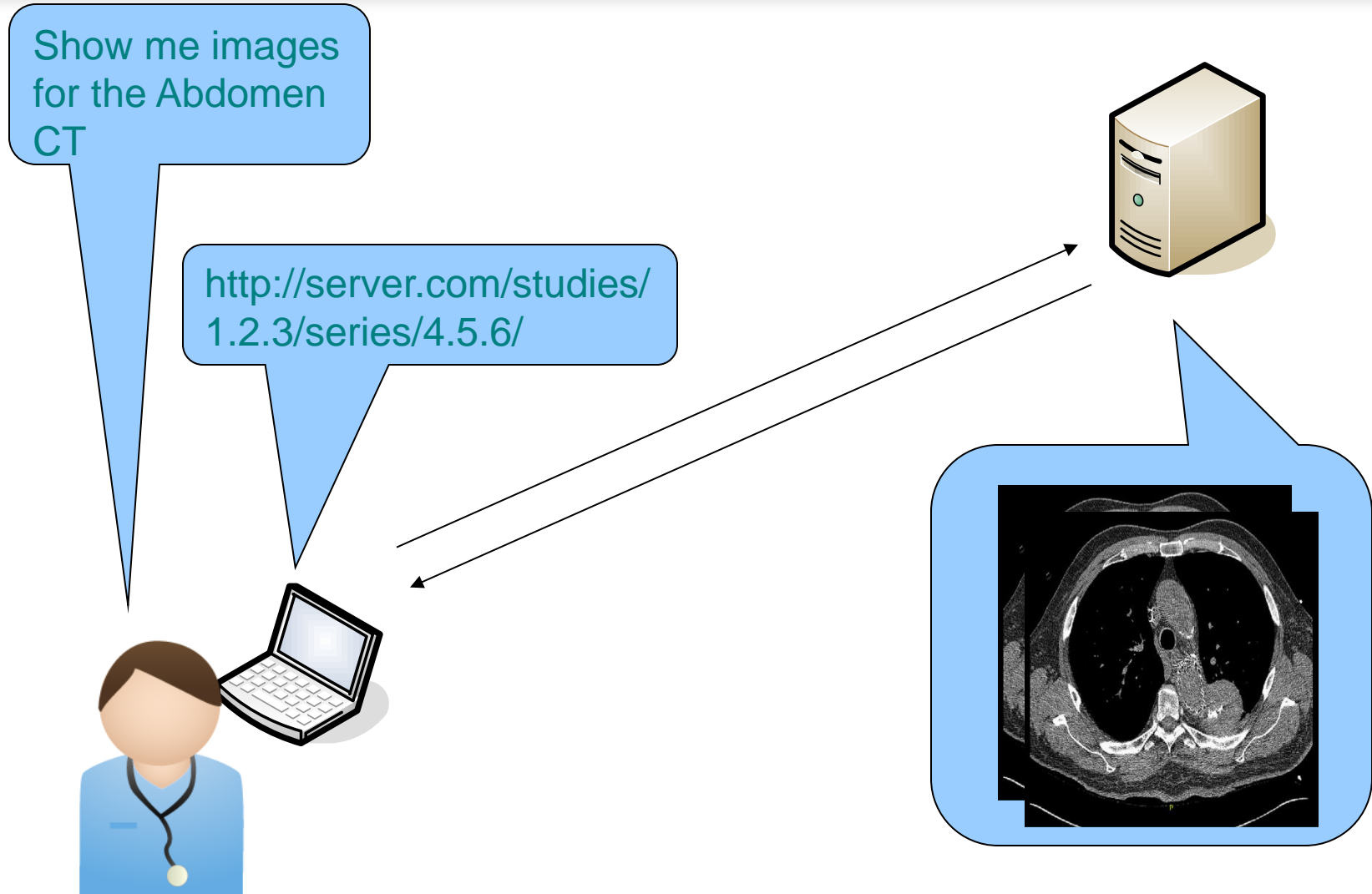
Upload with STOW-RS

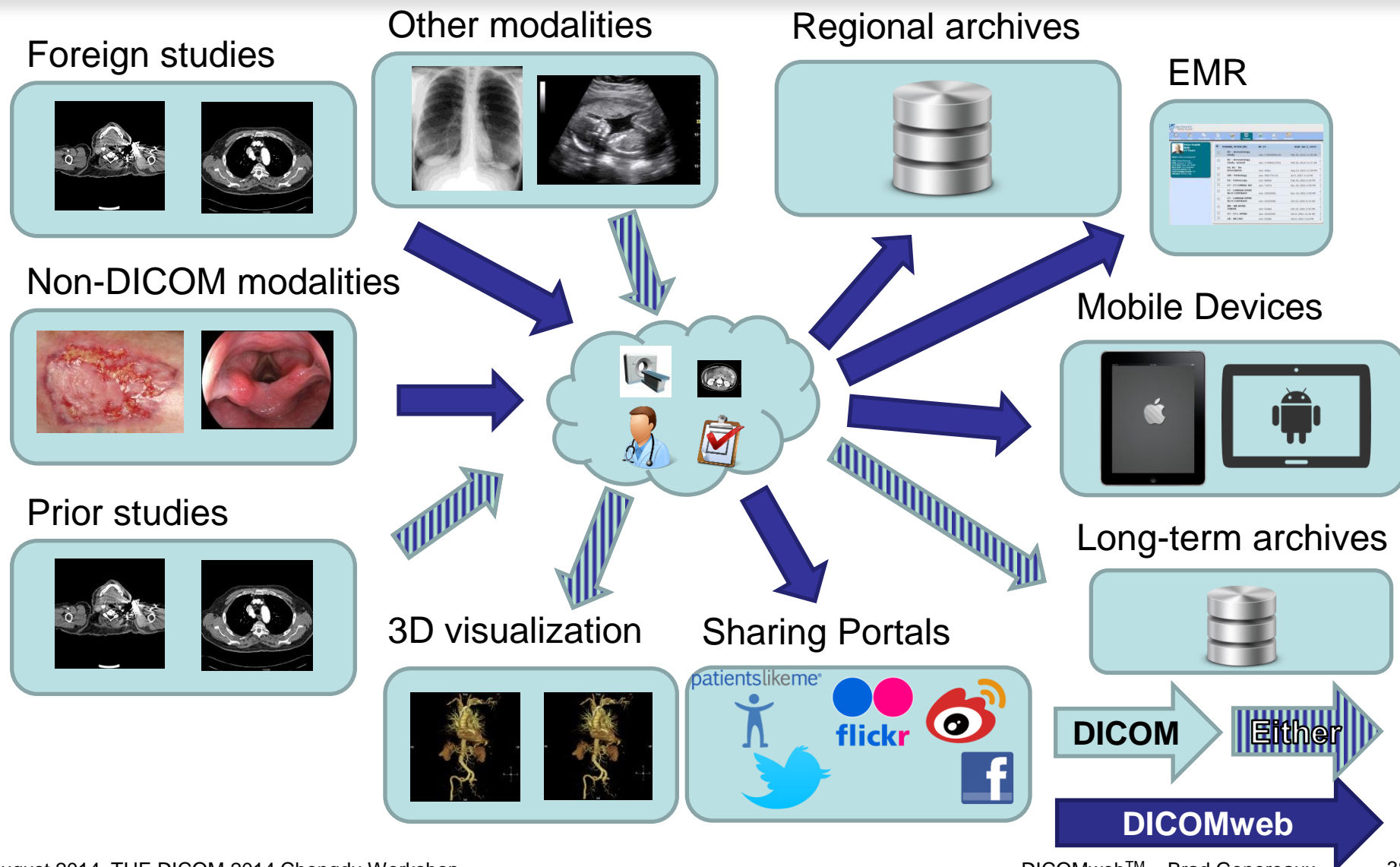| POST	**/studies/{StUID}**	Stores a set of instances
POST	**/studies/**	Stores a set of instances

STOW-RS Example

WADO-URI

- **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

- **Access to DICOM objects via SOAP**
- **"Simple Object Access Protocol"**
- **Used in IHE XDS-I transactions**
- **XML – HTTP based protocol**
- **Supports rendering of objects in web formats**
- **Retrieves and filters metadata**

Coming Soon in DICOMweb™

- **WADO-RS to include rendering**
  - **Currently only a feature of WADO-URI, -WS**
- **Discovery of server capabilities via "Server Options"**
- **Web workflow via Unified Procedure Step for RESTful Services (UPS-RS)**

In Summary

Thank You!

Questions?