

# DICOM RESTful Services

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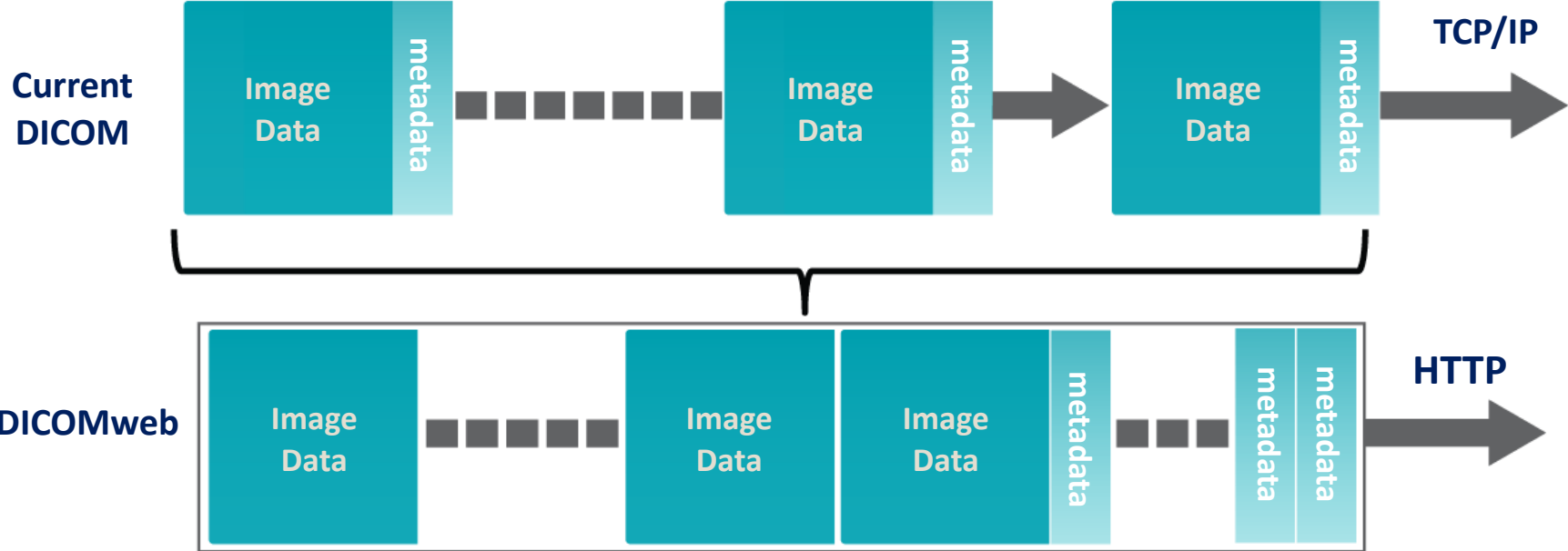
DICOM Standard Committee, User Co-Chair

DICOM WG-27, User Co-Chair

# Overview

- Anatomy of a Transaction
- Resources & Target URLs
- Representations & Media Types
- Studies Service
  - Resources
  - Transactions
  - Media Types
- Other Services
  - Worklist Service
  - Non-Patient Instance Service

# DICOM to DICOMweb



# Key Concepts

## Transaction

- composed of request/response message pair
- always initiated by a user agent request
- completed by an origin server *behavior* followed by a *response*.

## Resource

A *resource* is an abstract thing or concept that is reified by a *representation*, which is a data object contained in an octet-stream.

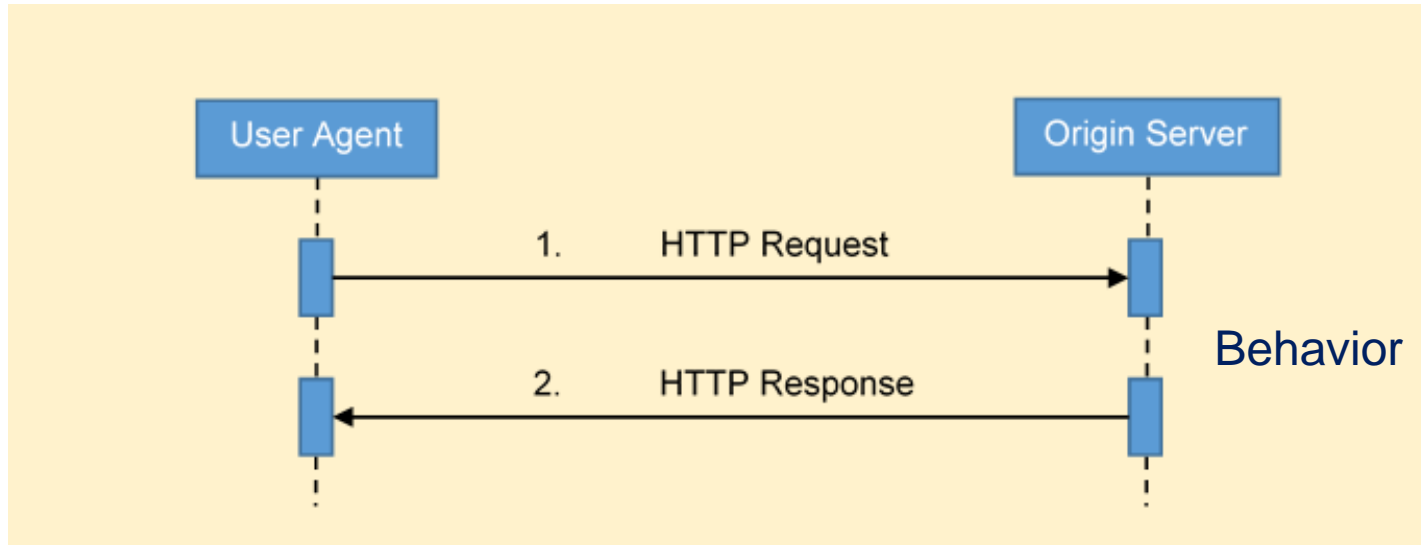
## Representation

A *representation* is a data object contained in an octet-stream that represents a resource.

## Media Type

A *media type* defines the format and algorithms needed for encoding and decoding resources into representations.

# HTTP Transactions



A Transaction is composed of request/response message pair.

Transactions are always initiated by a user agent request.

They are completed by an origin server *behavior* and *response*.

# HTTP Messages

- A sequence of bytes (octet-string)
- Message formats are specified using ABNF [RFC5234]
- US-ASCII Symbols (7-bit)
- No data types – that happens at another level

# Anatomy of Transaction

## HTTP Message

request-line / response-line  
header-fields  
CRLF  
[ payload ]

# Anatomy of Transaction

## HTTP Message

First line -> **request-line / response-line**  
Metadata -> **header-fields**  
Separator -> **CRLF**  
Content -> **[ payload ]**



# Anatomy of Transaction

## HTTP Message

First line -> **request-line** / **response-line**  
Metadata -> **header-fields**  
Separator -> **CRLF**  
Content -> [ **payload** ]

Where

**request-line** = method SP **/**{+resource}{?parameter\*} SP version  
**header-fields** = \*( header-field CRLF )

**/** ; alternatives – either request-line or response-line but not both  
**CRLF = %x13%x10** ; ASCII carriage return followed by linefeed – separates lines  
**[ ]** ; optional expression, may or may not be present

# Anatomy of Transaction Request Message

```
method SP /{+resource}{?parameter*} SP version
*(header-field CRLF)
CRLF
[ payload ]
```

**SP** = %x20 ; Space character - used as term separator

**CRLF** = %x13%x10 ; Carriage Return followed by Linefeed  
; used as line terminator


**\*** ; zero or more of the preceding expression

**( )** ; used to group terms

**[ ]** ; optional expression, may or may not be present

# Anatomy of Transaction Method

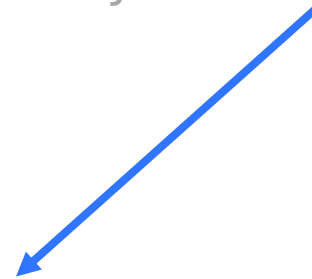
**method** SP /{+resource}{?parameter\*} SP version CRLF  
\*(header-field CRLF)  
CRLF  
[ payload ]



Methods	Description
CONNECT	Connect to a server
DELETE	Delete a resource
GET	Retrieve a representation
HEAD	Retrieve metadata
OPTIONS	Retrieve capabilities
POST	Action with a payload, e.g. store, search...
PUT	Replace a representation

# Anatomy of Transaction Version

```
method SP /{+resource}{?parameter*} SP version  
CRLF  
*(header-field CRLF)  
CRLF  
[ payload ]
```



**"HTTP/1.1" or "HTTPS/1.1"**

**Some day soon... "HTTP/2" or "HTTPS/2"**

# Anatomy of a Request

## Header Fields

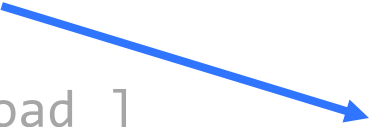
```
method SP /{+resource}{?parameter*} SP version CRLF
*(header-field CRLF)
CRLF
[ payload ]
```

### Content Negotiation Header Fields

Header Field	Usage	Description
<b>Accept</b>	<b>M</b>	All requests that may receive a response that includes a payload shall contain an Accept header field.
<b>Accept-Charset</b>	<b>O</b>	Indicates what charsets are acceptable in textual response content.
<b>Accept-Encoding</b>	<b>O</b>	The Accept-Encoding header field is used to indicate the transfer codings that are acceptable in the response.
Accept-Language	<b>O</b>	Indicate the set of natural languages that are preferred in the response

# Anatomy of a Request Header Fields

```
method SP /{+resource}{?parameter*} SP version CRLF
*(header-field CRLF)
CRLF
[ payload ]
```



## Payload Header Fields

Header Field	Usage	Description
<b>Content-Length</b>	<b>MC</b>	Specifies the decimal number of octets in the payload. It shall not be present if the message has a Content-Encoding header field. It should be present otherwise, <i>even is the size of the payload is zero.</i> <i>If the response message has a payload, and does not have a Content-Encoding header field, it shall have a Content-Length header field specifying the length in octets (bytes) of the payload.</i>
Content-Range	<b>MC</b>	Specifies the range of a partial representation contained in a payload.
Trailer	<b>MC</b>	See [RFC7230, Section 4.4 < <a href="https://tools.ietf.org/html/rfc7230#section-4.4">https://tools.ietf.org/html/rfc7230#section-4.4</a> >].
<b>Transfer-Encoding</b>	<b>MC</b>	See [RFC7230, Section 3.3.1 < <a href="https://tools.ietf.org/html/rfc7230#section-3.3.1">https://tools.ietf.org/html/rfc7230#section-3.3.1</a> >].

# Anatomy of a Request Header Fields

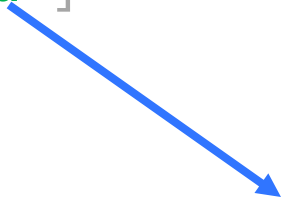
```
method SP /{+resource}{?parameter*} SP version CRLF
*(header-field CRLF)
CRLF
[ payload ]
```

## Content Representation Header Fields

Header Field	Usage	Requirement
<b>Content-Type</b>	<b>M</b>	Specifies the media type of the representation contained in the payload. If a message has a payload, it shall have a Content-Type header field.
<b>Content-Encoding</b>	<b>MC</b>	Specifies any content encodings applied to the representation and thus what decoding to apply to obtain a representation in the media type specified by the Content-Type. Content-Encoding allow <b>compression, encryption, and/or authentication</b> of representations.
Content-Language	<b>O</b>	Specifies the natural language(s) of the intended audience used in representation.
<b>Content-Location</b>	<b>MC</b>	Contains a URL that references the specific <b>resource</b> corresponding to the representation in the payload. It should be present in any message that has a payload containing a representation of a resource.

# Anatomy of a Request Payload

```
method SP /{+resource}{?parameter*} SP version CRLF  
*(header-field CRLF)  
CRLF  
[ payload ]
```



**An octet-string containing one or more representations**



# Anatomy of a Request

## Target Resource

```
method SP /{+resource}{?parameter*} SP  
version CRLF  
*(header-field CRLF)  
CRLF  
[ payload ]
```



The target resource is a URL composed of three components:

**/** Origin Server Root Path  
**{+resource}** Target Resource  
**{?parameter\*}** Query Parameters

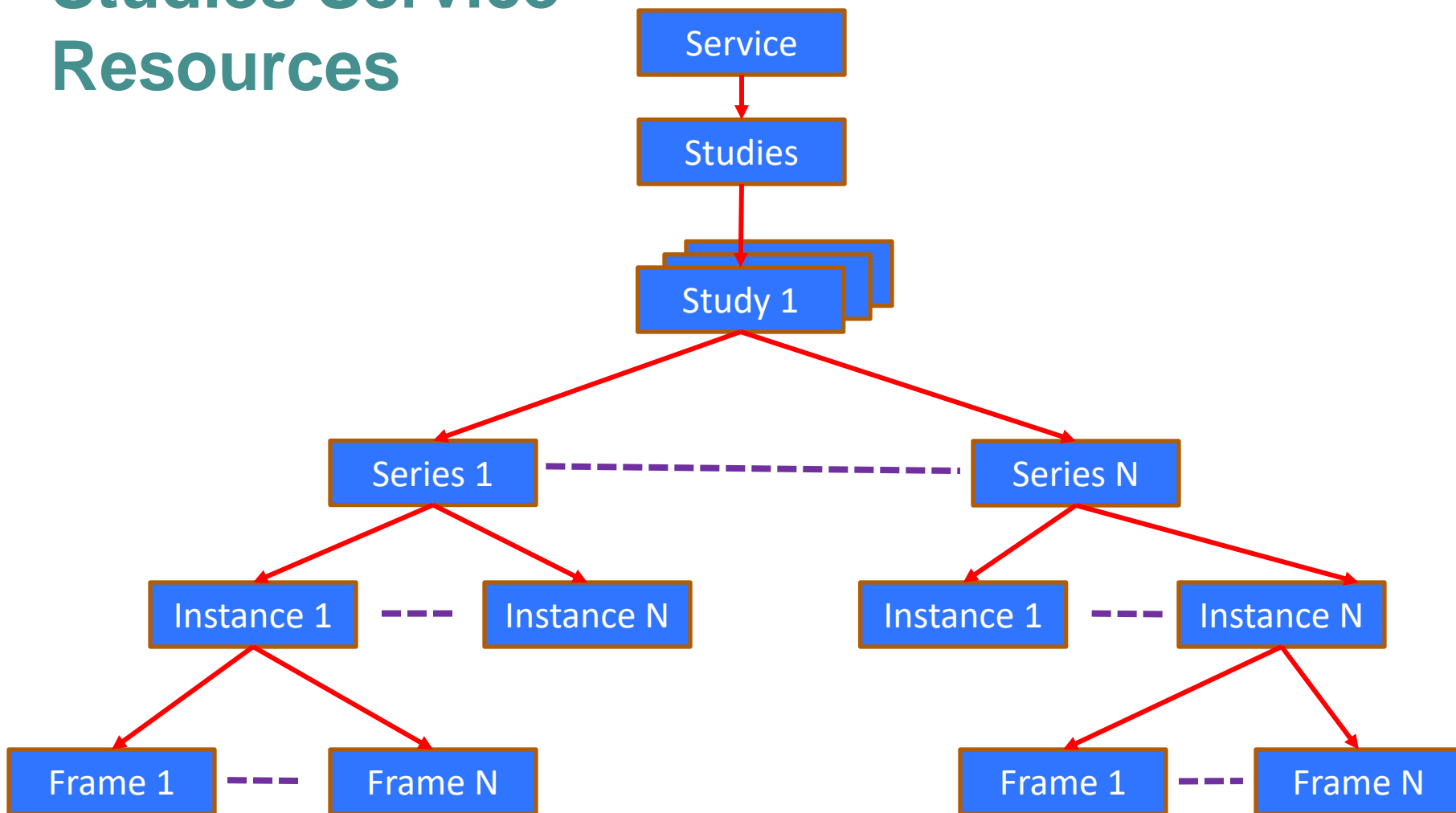
# Target Resource Template

**`/ {+resource} {?parameter*}`**

- Specified using URI Templates [RFC6570]
- { } enclose components
- + indicates that reserved characters may be used
- ? Indicates a query component parameter
- \* Indicate zero or more instances of the parameter
- ... and several other operators

# RESTful Studies Service

# Studies Service Resources



# Study Service Resources

## Resources, URI Templates and Descriptions

Resource	URI Template and Description
Studies Service	/
All Studies	/studies
Study	/studies/{study}
Study Metadata	/studies/{study}/metadata
Study's Series	/studies/{study}/series
Study's Instances	/studies/{study}/instances
All Series	/series
Series	/studies/{study}/series/{series}
Series Metadata	/studies/{study}/series/{series}/metadata
Series' Instances	/studies/{study}/series/{series}/instances
All Instances	/instances
Instance	/studies/{study}/series/{series}/instances/{instance}
Instance Metadata	/studies/{study}/series/{series}/instances/{instance}/metadata
Frame List	/studies/{study}/series/{series}/instances/{instance}/frames/{frame_list}
Bulkdata	/+bulkdata}

# Study Service Resources

## URI Template

/studies/{**study**}/series/{**series**}/instances/{**instance**}

## URL

/studies/1.2.3/series/4.5.6/instances/7.8.9

UID

# Studies Service Transactions

## Studies Service Transactions

Transaction	Method	Success Payload		Description
		Request	Response	
Retrieve Capabilities	OPTIONS	N/A	WADL	Retrieves a description of the Studies Service, including transactions, resources, query...
Retrieve DICOM	GET	N/A	Instance(s)	Retrieves DICOM representations
Retrieve Rendered	GET	N/A	instance(s)	Retrieves rendered representations
Store	POST	Instance(s)	N/A	Stores one or more DICOM representations
Search	GET	N/A	Result(s)	Searches the target resource and returns objects matching the search parameters

# Studies Service

## Transactions and Target Resources

Resource	Retrieve DICOM	Retrieve Rendered	Store	Search	Capabilities
Studies Service					X
All Studies			X	X	
Study	X	X	X		
Study Metadata	X				
Study's Series				X	
Study's Instances				X	
All Series				X	
Series	X	X			
Series Metadata	X				
Series' Instances				X	
All Instances				X	
Instance	X	X			
Instance Metadata	X				
Frame List	X	X			
Bulkdata	X	X			



# DICOM Media Types

## DICOM Media Types Supported by URI, WS, and RS Modes

Media Type	Default Charset	URI	WS	RS
application/dicom	US-ASCII	default	n/a	default
application/dicom+xml	UTF-8	n/a	required	required
application/json	UTF-8	n/a	n/a	required
application/octet-stream	<i>undefined</i>	n/a	recommended	required

# Rendered Media Types

## DICOM Transfer Syntax by Resource Class

Resource Class	Transfer Syntax Name	URI	WS	RS
<b>Single Frame Image</b>	image/dicom	default	default	default
	image/dicom+jpeg	recommended	recommended	recommended
	image/dicom+rle	recommended	recommended	recommended
	image/dicom+jpeg-ls	recommended	recommended	recommended
	image/dicom+jp2	recommended	recommended	recommended
	image/dicom+jpx	recommended	recommended	recommended
<b>Multi-Frame Image</b>	image/dicom	default	default	default
	image/dicom+jpx	recommended	recommended	recommended
<b>Video</b>	image/dicom	default	default	default
	video/mpeg	recommended	recommended	recommended
	video/mp4	recommended	recommended	required
	video/H265	recommended	recommended	recommended
<b>Other</b>	image/dicom	default	default	default

# Studies Service

## Retrieve Request

```
GET SP /{+resource} SP version CRLF
Accept: dicom-media-type CRLF
[ If-None-Match: entity-tag CRLF ]
*(header-field CRLF)
CRLF
```

# Studies Service

## Retrieve Response

```
version SP status-code SP reason-phrase CRLF
Content-Type: dicom-media-type CRLF
([ Content-Length: uint] /
 [ Transfer-Coding: coding]
 [ ETag: entity-tag CRLF]
 [ Last-Modified: http-date CRLF]
*(header-field CRLF)
CRLF
payload
```

# Studies Service

## Store Request

```
POST SP /studies[/study] SP version CRLF
Content-Type: dicom-media-type CRLF
*(header-field CRLF)
CRLF
payload
```

# Studies Service

## Store Response

```
version SP status-code SP reason-phrase CRLF
Content-Type: dicom-media-type
*(header-field CRLF)
CRLF
payload
```

# Studies Service

## Retrieve Request

```
GET SP /{+resource} SP version CRLF
Accept: dicom-media-type CRLF
*(header-field CRLF)
CRLF
```

# Conditional Retrieve Request

```
GET SP /{+resource} SP version CRLF
Accept: dicom-media-type CRLF
[ If-None-Match: entity-tag CRLF ]
*(header-field CRLF)
CRLF
```

Used to avoid unnecessary retrieves!



## Studies Service

# Conditional Store Request

```
POST SP /studies[/study] SP version CRLF
Content-Type: dicom-media-type CRLF
[ If-None-Match: entity-tag CRLF ]
*(header-field CRLF)
CRLF
payload
```

Used to ensure consistent updates!

# Studies Service

## Search Request

```
POST SP /{+resource}{?parameter*} SP version CRLF
Accept: 1#docom-media-type CRLF
*(header-field CRLF)
CRLF
payload
```

```
{?parameter*} = ?{&match*}
                {&fuzzymatching}
                {&includefield*}
                {&offset} {&limit}
```

# Studies Service

## Search Request

{&match\*} = #(attribute “=” values)

{&fuzzymatching} = “fuzzymatching=” “true” / “false”

{&includefield\*} = “includefield=” (1#attribute / “all”)

{&offset} = “offset=” uint

{&limit} = “offset=” uint

# Studies Service

## Search Response

```
version SP status-code SP reason-phrase CRLF
Content-Type: dicom-media-type
*(header-field CRLF)
CRLF
payload
```

# Work in Progress

## Notifications

Transaction	Method	Success Payload		Description
		Request	Response	
Open Channel	UPGRADE	No	SDD	Opens a notification channel between user agent and origin server
Send Event	**	Report	Ack/Nck	Origin server sends an event notification
Create Subscription	POST	No	SDD	User agent subscribes for notifications
Delete Subscription	DELETE	No	SDD	User agent deletes subscription

**Questions?**

# RESTful Studies Service Overview

- A DICOM Study Storage Service
- Resources  
Studies, Series, Instance, Frames, Metadata, Bulkdata
- Media Types
  - Application/dicom
  - Application/dicom+xml
  - Application/json
- Transactions
  - *Retrieve* DICOM representation
  - *Retrieve* rendered representations
  - *Store* DICOM representations
  - *Search* for DICOM resources