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DICOM RESTFUL SERVICES

JIM PHILBIN

AMERICAN COLLEGE OF RADIOLOGY

DICOM STANDARD COMMITTEE, USER CO-CHAIR

DICOM WG-27, USER CO-CHAIR

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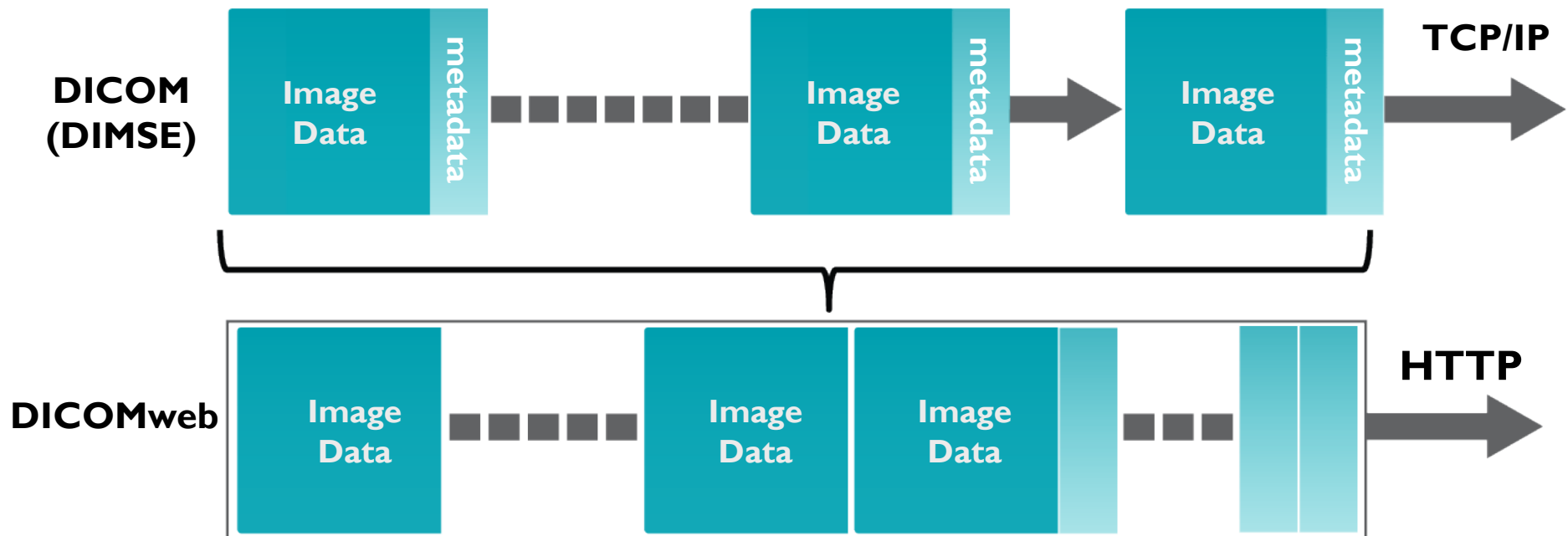
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Overview

- 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.

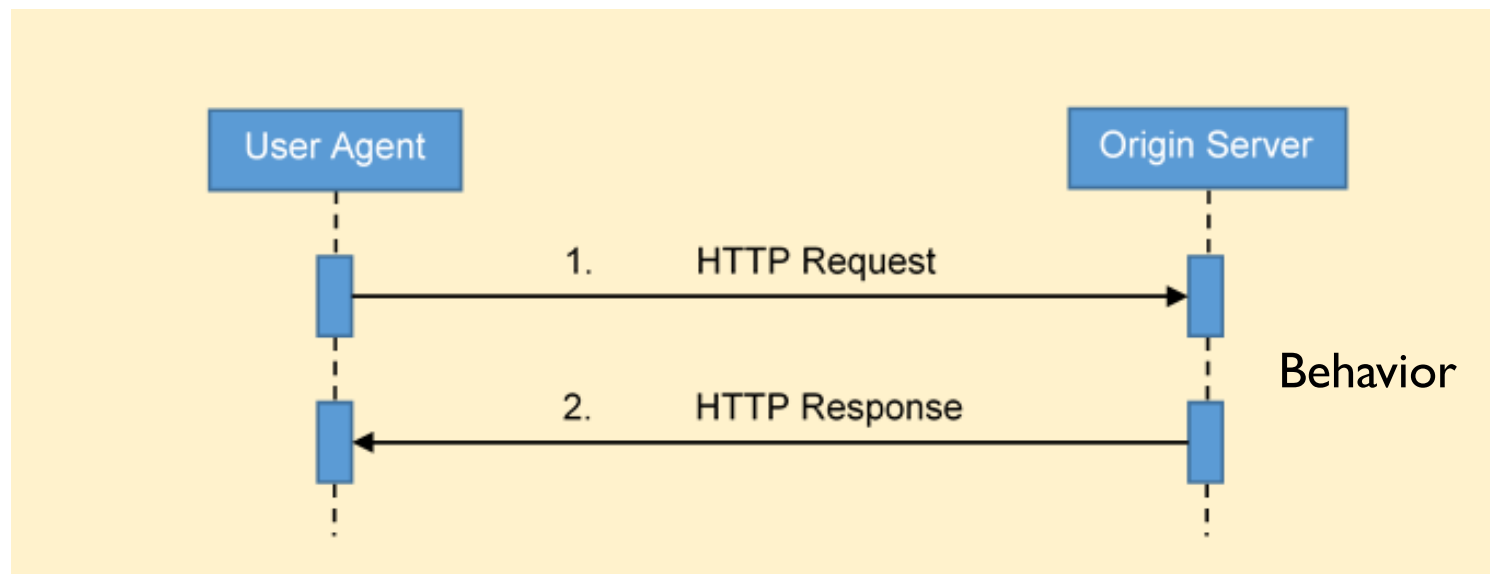
Representation

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

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

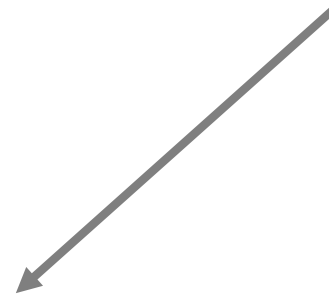
Anatomy of Transaction Method

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 (I)

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




Content Negotiation Header Fields

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

**Specifies user agent support requirement. All header fields are mandatory for origin server*

Anatomy of a Request Header Fields (2)

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



Payload Header Fields

Header Field	Usage	Description
Content-Length	MC	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	MC	Specifies the range of a partial representation contained in a payload.
Trailer	MC	See [RFC7230, Section 4.4 < https://tools.ietf.org/html/rfc7230#section-4.4 >].
Transfer-Encoding	MC	See [RFC7230, Section 3.3.1 < https://tools.ietf.org/html/rfc7230#section-3.3.1 >].

Anatomy of a Request Header Fields (3)

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

Content Representation Header Fields

Header Field	Usage	Requirement
Content-Type	M	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.
Content-Encoding	C	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-Encodings allow compression, encryption, and/or authentication of representations.
Content-Language	O	Specifies the natural language(s) of the intended audience used in representation.
Content-Location	C	Contains a URL that references the specific resource 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

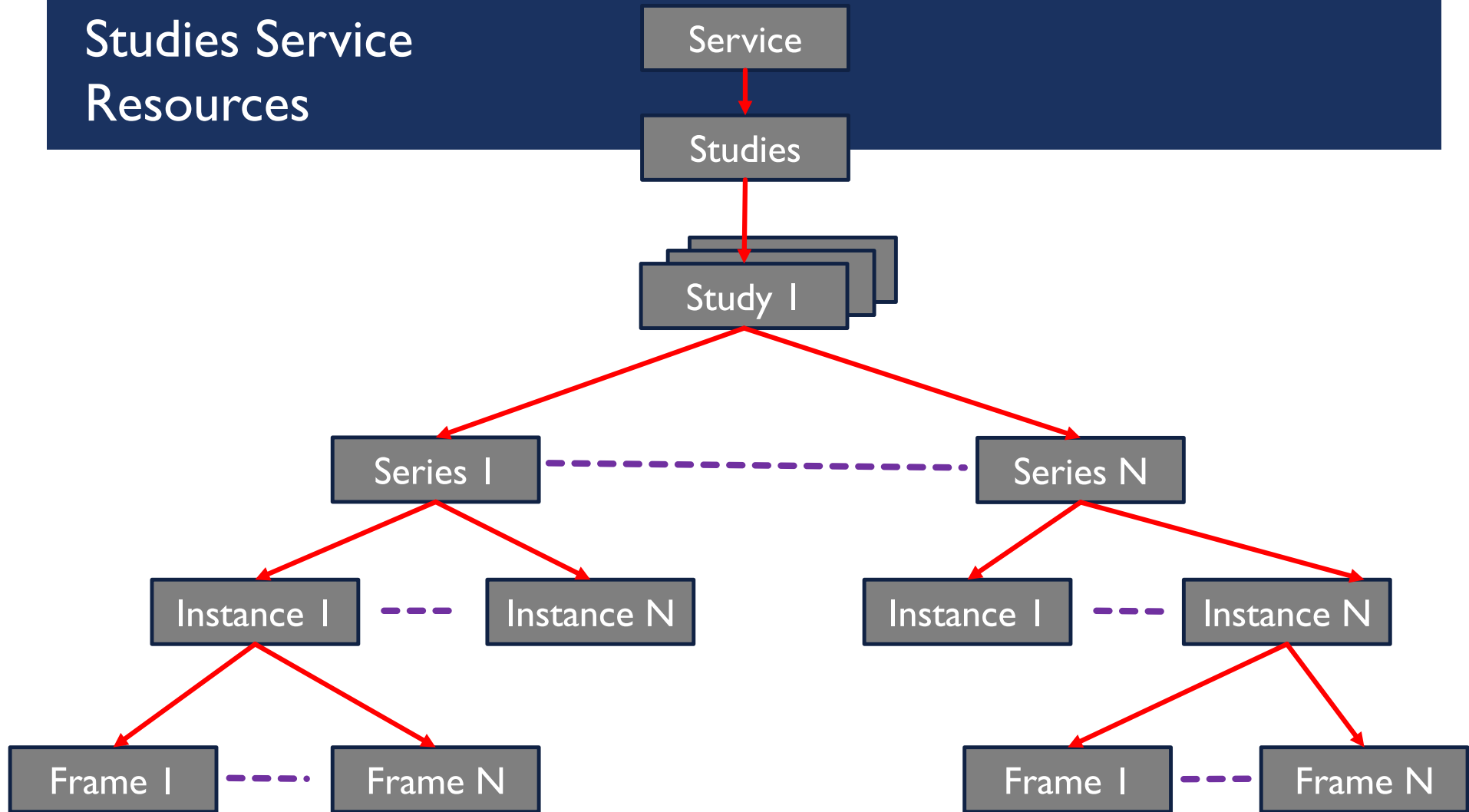
Target Resource Template

`/{+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 (& separator)
- ... and several other operators

RESTful Studies Service (RS)

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 (RS Capabilities Service)	OPTIONS	N/A	WADL	Retrieves a description of the Studies Service, including transactions, resources, query...
Retrieve DICOM (WADO-RS)	GET	N/A	Instance(s)	Retrieves DICOM representations
Retrieve Rendered (WADO-RS)	GET	N/A	instance(s)	Retrieves rendered representations
Store (STOW-RS)	POST	Instance(s)	N/A	Stores one or more DICOM representations
Search (QIDO-RS)	GET	N/A	Result(s)	Searches the target resource and returns objects matching the search parameters
Worklist Service (UPS-RS WL)	POST or GET	Action dependent	Action dependent	Manages the Worklist of studies to be performed

Studies Service Transactions and Target Resources

Resource	Retrieve DICOM (WADO-RS)	Retrieve Rendered (WADO-RS)	Store (STOW-RS)	Search (QIDO-RS)	Capabilities (SC-RS)	UPS Worklist (UPS-RS WL)
Studies Service					X	
UPS Instances						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
Single Frame Image	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
Multi-Frame Image	image/dicom	default	default	default
	image/dicom+jpx	recommended	recommended	recommended
Video	image/dicom	default	default	default
	video/mpeg	recommended	recommended	recommended
	video/mp4	recommended	recommended	required
	video/H265	recommended	recommended	recommended
Other	image/dicom	default	default	default

Studies Service Retrieve Request (WADO-RS)

```
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 (WADO-RS)

```
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 (STOW-RS)

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

Studies Service Store Response (STOW-RS)

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

Studies Service Retrieve Request (WADO-RS)

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

Studies Service Search Request (QIDO-RS)

```
POST SP /{+resource}{?parameter*} SP version CRLF
```

```
Accept: |#docom-media-type CRLF
```

```
*(header-field CRLF)
```

```
CRLF
```

```
payload
```

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

Studies Service Search Request (QIDO-RS)

`{&match*}` = `#(attribute “=” values)`

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

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

`{&offset}` = “offset=” uint

`{&limit}` = “offset=” uint

Studies Service Search Response (QIDO-RS)

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


Studies Service

Other Services (UPS-RS WL and NPI-RS)

- UPS-RS Worklist Service
 - DICOMweb version of DICOM Worklist
- RS Non-patient Instance (NPI) Storage
 - For storing information that is not related to one particular patient (palettes, protocols, templates...)

Work in Progress Notifications (NADO-RS)

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 (WADO-RS)
 - *Retrieve* rendered representations (WADO-RS)
 - *Store* DICOM representations (STOW-RS)
 - *Search* for DICOM resources (QIDO-RS)

Author Contacts

James Philbin, jim@philbin.us

- Poplar Hill Informatics
American College of Radiology
USA



Emmanuel Cordonnier, emmanuel.cordonnier@b-com.com

- b<>com
1219 avenue des Champs Blancs
35510 Cesson-Sévigné
France
- [Example of DICOMweb™ implementation](#)



Thank you for your attention!