X-PACS and X-Referral
-a standards update-
IHE MHD, HL7 FHIR and RESTful DICOM
René Spronk

Trainer / Senior Consultant
Ringholm bv
Haarlem, the Netherlands

Tel. +31 (0)33 7 630 636
eMail: Rene.Spronk@Ringholm.com
Web: http://www.Ringholm.com

HL7/IHE roles:
• Co-chair of the international
  Application Implementation and Development (AID) HL7 User Group
• Co-chair of various Committees, HL7 Netherlands
• Contributor to the IHE Laboratory Technical Framework
• HL7 Fellow, 2011
Standards evolve..

• X-PACS, X-Referral
  – IHE XDS, HL7 CDA, DICOM
• New developments
  – HL7 for mobile apps (HL7 FHIR)
  – XDS for mobile apps (IHE MHD)
  – DICOM for mobile apps (RESTful DICOM)
What is REST?

• **RE**presentational **St**ate **T**ransfer

• RESTful services follow certain principles
  – Addressable Resources (URI); Each resource has a unique id
    • http://myserver.org/patient/123
    • http://mypacs.net/study/1/series/5/image/9
  – Uniform, Constrained Interface (HTTP)
    • GET, PUT, DELETE (crud)
  – Stateless
  – Hypermedia
HL7 FHIR

Fast Healthcare Interoperability Resources
What is a FHIR ‘Resource’?

- Small, discrete concepts that can be maintained independently
  - Akin to HL7v2 segments, HL7v3 CMETs, DICOM IEs.
- Resources are smallest units of transaction
- Built-in extension mechanism
  - Elements used by 80% of implementers are part of the base resource.
    - All other elements are handled as extensions
- Resources have a ‘textual description’
Example - Person

```xml
<Person xmlns="http://www.hl7.org/fhir">
  <id> mand id Master Resource Id, always first in all resources</id>
  <identifier> Zero+ HumanId A Human identifier for this person </identifier>
  <name> Zero+ HumanName A name associated with the person </name>
  <address> Zero+ Address An address for the person </address>
  <contact> Zero+ Contact A contact detail for the person </contact>
  <dob> opt dateTime The birth date for the person </dob>
  <gender> opt CodeableConcept Administrative Gender </gender>
  <religion> opt CodeableConcept Religion of the person </religion>
  <qualification> <!-- Zero+ Qualifications, Accreditations, Certifications -->
    <id> opt Identifier Identifier for the qualification </id>
    <code> opt CodeableConcept A code for the qualification </code>
    <institution> opt (Organization) Who conferred it </institution>
    <period> opt Interval(date) When the qualification is valid </period>
  </qualification>
  <language> <!-- Zero+ -->
    <code> mand code ISO 639-3 code for language </code>
    <use> opt code How well the language is used </use>
  </language>
  <relatedPerson> <!-- Zero+ Kin, Guardians, Agents, Caregivers -->
    <id> opt HumanId Identifier for the person </id>
    <role> mand CodeableConcept Type of relationship </role>
    <name> opt HumanName Name of the person </name>
    <contact> Zero+ Contact Contact details for the person </contact>
  </relatedPerson>
  <extensions> opt See Extensions </extensions>
  <text> mand Narrative Text summary of person, for human interpretation </text>
</Person>
```
FHIR Examples

GET http://myfhirserver.com/patient/123

GET http://myfhirserver.com/encounter/404?_include=patient

PUT http://myfhirserver.com/encounter/707 {XML or JSON Resource expression}

GET http://myfhirserver.com/document/800511
IHE MHD
Mobile access to Health Documents
IHE XDS/MHD Profiles

RESTful services; XML/JSON Resource-like objects
Intent is to harmonize with HL7 FHIR
DICOM

RESTful DICOM Protocols
Traditional DICOM Transport

Several minutes over Gig/E

Once all images have been received, the viewer can figure out how to display them

Transmission is organized at the SOP Instance level:

Metadata

- Study
- Series
- SOP Instance
- Pixel Data

Study
Series
SOP Instance
Pixel Data

PACS

Viewer
RESTful DICOM Transport

**Viewer**
- Get Metadata
- Return metadata

**PACS**
- Once metadata is received, the viewer can figure out what images it needs
  - Get Image #1-2000
  - Return Images #1 - 2000

Several seconds over Gig/E

**Metadata**
- Patient
- Study
- Series
- SOP Instances

**Image**
- Voice Clip
- Private Attributes

-IHE ACADEMY - The Netherlands
Putting it together…

• Metadata separated from image data
• Fetch
  – Simple URL-based search (UID based)
  – Parse XML or JSON response
  – Launch viewer for selected study
  – Download metadata, subset of images
  – Download rest of study in background
• Upload
  – new evidence / artifacts, entire studies
## Image IOD

<table>
<thead>
<tr>
<th><strong>Patient</strong></th>
<th><strong>Study</strong></th>
<th><strong>Series</strong></th>
<th><strong>Equipment</strong></th>
<th><strong>Image</strong></th>
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<tbody>
<tr>
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<td>Study UID</td>
<td>Series UID</td>
<td>Manufacturer</td>
<td>Acquisition Attributes...</td>
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<td>Study Date</td>
<td>Series Number</td>
<td>Institution Name</td>
<td>Position Attributes...</td>
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<tr>
<td>Patients’ Birth Date</td>
<td>Study Time</td>
<td>Modality Type</td>
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<td>Study ID</td>
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<td>Referring Physician</td>
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<td>Bits Allocated, Bits Stored</td>
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<td></td>
<td>Accession Number</td>
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<td>Samples per Pixel</td>
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<td>Window Center</td>
</tr>
</tbody>
</table>

**SOP Common**
- SOP Class UID
- SOP Instance UID

**General Study**
- Patient

**General Series**
- General Study

**General Equipment**
- General Series

**System Depended**
- General Equipment

**Image Pixel**
- System Depended

**VOI LUT**
- Image Pixel
Example: Mobile Digital Pathology

- Full X20 image, 60000x40000 pixels (7Gb, 200Mb compressed)
- This view: 1000x550 pixels
## Mobile Digital Pathology

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</tbody>
</table>

1. http://mypacs.net/image/1234?region=27800,17200,27900,17400&res=300
2. http://mypacs.net/image/1234?region=27900,17200,28000,17400&res=300

.... Etc. etc.
FHIR+MHD+RESTful DICOM

- Fetch Patient (FHIR)
- Fetch Documents (MHD)
  - Documents could reference (by URL on a different server):
    - a FHIR Patient and Encounter,
    - a DICOM Image
- Fetch Images (RESTful DICOM)
  - Image could reference (by URL on a different server):
    - a FHIR Patient
Status of these standards

• IHE MHD: ‘trial implementation’ status
  – www.ihe.net/Technical_Frameworks
• HL7 FHIR: ‘draft standard for trial use’
  – www.hl7.org/fhir
• RESTful DICOM (sup 161,163, 166): final
  – medical.nema.org
Questions ?