DICOM: short introduction

- Digital Imaging and Communications in Medicine
- Based on binary exchange protocol over TCP/IP or external media
- Meta Data and Image Data
- Concept of an attribute (example)
  
tag name: Patient Name
  tab number: 0x00100010
  value representation: PN
DICOM: Model of the Real-World

Model image taken from Nema: PS 3.3 2008 p. 54

A partial ontology might look like this (namespace omitted):

Patient hasStudy Study
Study containsSeries Series
Series isSeriesOf Study
DICOM and RDF state of the art

• DFKI: MEDICO
  DICOM annotations stored in RDF
  (http://www.manuelm.org/blog/?tag=dicom)

• Standford University: DICOM ontology
  (http://bmir.stanford.edu/projects/view.php/dicom_ontology_do_project)

• Mostly focusing on making images semantically accessible
RDF Resources in SeDI

• Resources
  – Patient
  – Study (DICOM: StudyInstanceUID)
  – Series (DICOM: SeriesInstanceUID)

• Problem
  – DICOM has no Patient UID
  – Several patient merge criteria, e.g. PatientName, PatientBirthDate, etc.
RDF Resources in SeDI

• Patient Resource URI
  – Study Centric Model
    • Each Study has exactly one Patient
    • For example: dcm#Patient_StudyInstanceUID
      (dcm#Patient_1.2.392.200036.9116.2.1.1.8812167.235)
    • Used by SeDI
  – Hashing Patient Information
    • Defined by vendor or institution
    • For example: dcm#Patient_Name_BirthDate
SeDI: going beyond DICOM

- DICOM has no separate concept for a physician
  - ReferringPhysician (Study)
  - PerformingPhysician (Series)
- A common sense concept – though impractical for DICOM – is to introduce a physician Resource
Physician Resource in SeDI

• Defined in the ontology as

:Physician rdf:type owl:Class ;

:ATT00080090 rdf:type owl:ObjectProperty ;
  rdfs:range :Physician ;
  owl:equivalentProperty :ReferringPhysicianName ;
  rdfs:domain :Study .
Physician Resource in SeDI

• Defined in ontology (cont'd)

AttendingPhysicianName rdf:type owl:ObjectProperty ;
owl:propertyChainAxiom ( :hasStudy
:ReferringPhysicianName ) .

![Diagram showing the relationship between Patient, Study, and Physician]
Physician Resource in SeDI

• Currently SeDI uses StudyInstanceUID for encoding:
dcm#Physician_StudStudyInstanceUID

• Problem
  – Physician can be connected to Series instead of Study
  – No common concept for identifying physicians in DICOM
Architecture of SeDI

FE

HTTP

SPARQL endpoint

SPARQL

FE

Jena / Pellet

dcm4che

Joseki / Tomcat

Web-Service

DICC

PACS

dcm4chee

JBoss

Java / J2EE

MySQL

Web-Service

DICOM-Node

3. Mrz 2010

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Generating Resources from DICOM query result sets

- **Study Centric Model**
  - DICOM query result set contains attributes and their values for a Study, e.g.:
    
    | StudyInstanceUID | 1.23.2323.232323.23 |
    | PatientName       | John^Doe |

- **PatientName (DICOM Attribute 00100010):**
  
  :ATT00100010 rdf:type owl:DatatypeProperty ;
  rdfs:domain :Patient ;
  owl:equivalentProperty :PatientName ;
  rdfs:range xsd:string .
Generating Resources from DICOM query result sets

• Algorithm:
  – DICOM attribute is a property in the ontology
  – Take the domain of the attribute
  – Generate a resource from the domain
  – Put this resource and attribute encoded as property in the RDF result

example from above:

dcm#Patient_1.23.2323.2323232.23 a Patient
dcm#Patient dcm#PatientName "John^Doe"
DICOM Query with SPARQL

• Demo
Generating Resources from DICOM query result sets

- Planned Improvements
  - `owl:HasKey` for identifying identical resources despite of different URIs
  - Merging criteria defined for specific vendors, machines, which have a defined Instance Root UID
  - Merging criteria written in owl in a separate ontology
Wrap Up

• Architecture Overview

CT / MR / RT / etc.  

DICOM

SPARQL / RDF / OWL

Semantic application

PACS
Conclusion

• Semantic Approach
  – Accessible for domain experts
  – Integration of new semantical data stores
  – One layer of abstraction for developers

• Combined with traditional Approach
  – Securing investments
  – No impact on running projects
  – Engineers still can use proven technologies