Standards in Medical Imaging:
A Tale of Two Layers

Presenter:
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DICOM: Traditional Data Standard

- Defining how to encode and exchange information with unambiguous semantics

- Broad scope
  - Intentionally addresses MANY use cases
  - “Swiss Army Knife”
  - Generalize, inclusive,

- Priority: make most/all things possible
  - You decide how to apply it to your problem
IHE : Profiling

• Profiling: Describing the application of **existing standards** to address a **specific use case**

• Narrower Scope:
  – Focus on ONE use case

• Constrain Underlying Standards
  – Select among alternative methods
  – Remove/reduce optionality

• Priority: Interoperability; common usage
IHE in One Slide

- IHE helps vendors implement & test functions that span multiple systems
- Profiles are implementation guides
  - how to use existing standards
  - to address a specific problem scenario
- Connectathons are test events
  - managed testing of Profile implementations
- IHE helps users purchase & integrate multi-system solutions
  - list required IHE Profile support in RFPs
DICOM & IHE Similarities

• Open Process
  – Permit & encourage participation by all stakeholders
  – Public Comment for wider input

• Freely Available
  – dicom.nema.org
  – www.ihe.net

• Ongoing Development
  – Maintenance & extension process
  – New supplements every year
## DICOM & IHE - Differences

<table>
<thead>
<tr>
<th>DICOM</th>
<th>IHE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-ended development</td>
<td>Annual cycle</td>
</tr>
<tr>
<td>Published ~5 times per year</td>
<td>Published annually</td>
</tr>
<tr>
<td>DICOM Conformance Statement</td>
<td>IHE Integration Statement</td>
</tr>
<tr>
<td>- Detailed functionality (Long)</td>
<td>- Profile/Actor summary (Brief)</td>
</tr>
<tr>
<td>Occasional implementation demos</td>
<td>Annual Connectathon test events</td>
</tr>
<tr>
<td>Central oversight (WG-6)</td>
<td>Varies by domain</td>
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Examples of Layering

• Simple Case: Radiation Records
  – Adding Architecture
    • DICOM Radiation Dose Structured Report object
    • IHE Radiation Exposure Monitoring Profile

• Advanced Case: Imaging Workflow
  – Assembling Services
    • DICOM Worklists + DICOM MPPS + DICOM Storage + DICOM Storage Commitment
    • IHE Scheduled Workflow Profile
  – Bridging Standards
    • HL7 Orders -> DICOM Worklists
DICOM RDSR

Radiation Dose Structured Report Object

<table>
<thead>
<tr>
<th>NL</th>
<th>Rel with Parent</th>
<th>VT</th>
<th>Concept Name</th>
<th>VM</th>
<th>Req Type</th>
<th>Condition</th>
<th>Value Set Constraint</th>
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<tbody>
<tr>
<td>1</td>
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<td>4</td>
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DICOM Dose Reports

• “SR Objects” – DICOM Structured Reports
  – Easily ingested (and regurgitated) by PACS

• Granularity: “Irradiation Event”
  – & Accumulated Dose over Study, Series

• Templates:
  – CT, Projection X-Ray (Mammo, Fluoro, DR/CR)
  – PET/NM

• Not addressed: RT
Key Measurements

- **CT Dose**
  - DLP, CTDIvol, kVP, mA, sec, ...
  - SSDE [Optional; see AAPM 204]

- **Projection X-Ray Dose**
  - DAP, Dose@RP, kVP, mA, sec, Fluoro Time, ...
  - CR/DR: Exposure Index, Deviation Index

- **Mammography Dose**
  - AGD, Entrance Exposure@RP, kVP, mA, sec, ...
  - Compression, Half Value Layer

- **Nuclear Medicine (New)**
  - Administered Activity, Date/time, Route of Administration, ...

Other Details in Dose SR

- Full Patient / Order / Study Details
- Unique ID for each Irradiation Event
- Equipment ID, Ordering Doc, Performing Tech
- Patient Size, Orientation, Anatomy Imaged
- Imaging Geometry
- X-Ray Filtering & Collimation Details
- Anode Target Material
- Calibration, Phantom, Dosimeter, Patient Model
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Trip to IKEA

• Off-the-shelf…
  – 43 vendors passed IHE Connectathon testing
  – 34 modality products (CT, XA, DR, MG)
  – All major CT vendors shipping in 2012
  – 26 archive products, 18 dose “consumers”
  – 9 dose reporters, 4 dose registry

• NEMA XR-25 & 29 – CT Dose Check, etc
  – All new CT products
Integrating the Healthcare Enterprise Radiation Exposure Monitoring
The pieces exist; Assembly is straightforward
Using SR Dose Reports

• Radiation QA
  – Periodically Query / Retrieve Reports from Archive
  – Set policies/standards and flag deviations
  – Set goals for improvement and track progress
  – Implement protocol changes and compare difference in dose

• Regulation
  – E.g. Automatically insert dose metrics into diagnostic reports

• Patient Impact Evaluation
  – E.g. if Patient identified after the scan as pregnant

• Dose Mapping
  – Store data in realtime from Modality to Mapping Workstation
Using SR Dose Reports

• National Registries
  – Anonymize and submit Dose Reports to Registry
  – Compile Population Risk Estimations
  – Derive Dose Reference Levels (DRLs)
  – Provide Site-Site Comparisons

• Individual Dose Record
  – Collect Dose Reports over time

• Clinical Trials
  – Collect Dose together with Images
  – Demonstrate both improved detection & reduced dose
Finding Products

• IHE REM

• DICOM RDSR
  – Product: DICOM Conformance Statement

• NEMA XR-25 Dose Check
  – Vendor commitment; all new products
Examples of Layering

• Simple Case: **Radiation Records**
  – Adding Architecture
    • DICOM Radiation Dose Structured Report object
    • IHE Radiation Exposure Monitoring Profile

• Advanced Case: **Imaging Workflow**
  – Assembling Services
    • DICOM Worklists + DICOM MPPS + DICOM Storage + DICOM Storage Commitment
    • IHE Scheduled Workflow Profile
  – Bridging Standards
    • HL7 Orders -> DICOM Worklists
Actor / Transaction Diagram*

* Now with improved symmetry
Key DICOM Services

- **DICOM Modality Worklist**
  - Provide demographics and order details

- **DICOM Modality Performed Procedure Step (MPPS)**
  - Provide logging/tracking of procedure status

- **DICOM Storage Commitment**
  - Provide confirmation of data storage

- **DICOM Instance Availability Notification**
  - Provide notification of data availability
Modality Worklist – Query

• Modality (SCU) queries RIS (SCP)
  – Query can include filters: (AKA Matching Key Attributes)
    • Date/Time of Study
    • Patient Name, ID
    • Accession #
    • Performing System Name
    • Modality
    • Etc.
  – May indicate desired Return Key Attributes

  – Query strategies
    • Narrow query – try to just get specific results
    • Broad query – do additional result filtering on the modality
MPPS – In Progress

• Indicates a procedure step is In Progress
• Timing is not prescribed
  – SCU may send at “start of procedure”
  – SCU may send after completion

• Tracking Attributes
  – Accession#, SPS ID, Study UID
  – Patient Demographics, etc
  – Logical to populate these from the Modality Worklist

• May provide progress details
  – Data produced
  – Protocol codes performed

• Implicit “Notification” of unscheduled/trauma cases
  – MPPS does not correspond to any SPS
  – SCP may choose to “backfill” an order or perform other reconciliation
MPPS – Usage

• Billing
  – Details of procedures actually performed
  – Can bill sooner and more accurately

• Procedure Status Monitoring
  – Ordering physician can see if started/acquired/cancelled

• Workflow
  – Radiologist can see exams pending/ready for reading

• Patient Tracking
  – Know where patient is/was at a certain time

• Key Benefits
  – Accurate, detailed data on performed steps
  – Can provide up to date status
Storage Commitment – Usage

• Modality requests after storage complete
• Catches network outage losses
• Catches PACS outage losses
• Catches “I thought the morning shift staff sent all their studies to PACS” losses

• Key Benefits
  – Reduces lost data
  – Eliminates manual confirmation time
## Mapping HL7 Order to DICOM MWL

<table>
<thead>
<tr>
<th>DICOM Attribute</th>
<th>DICOM Tag</th>
<th>HL7 Description</th>
<th>HL7 v2.3.1 Segment</th>
<th>HL7 v2.5.1 Segment</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Patient's Name</td>
<td>(0010,0010)</td>
<td>Patient Name</td>
<td>ORM PID:5</td>
<td>OMG PID:5</td>
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<td>Patient ID</td>
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<td>External Patient ID</td>
<td>ORM PID:3.1</td>
<td>OMG PID:3.1</td>
<td>See note 5</td>
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<td>Ordering Provider</td>
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<td>OMG OBR:16</td>
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<td>Accession Number</td>
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<td>Reason for the Requested Procedure</td>
<td>(0040,1002)</td>
<td>Reason for Study</td>
<td>ORM OBR:31</td>
<td>OMG OBR:31</td>
<td>May be a code or text; if code, then code meaning (display name) should be used; see also (0040,100A)</td>
</tr>
</tbody>
</table>
A Profile in Two Parts

- Scheduled Workflow (SWF)
  - Order & acquisition workflow
  - ADT, HIS, RIS, PACS, Modality, Workstation
  - “Backbone of Radiology”
    - Electronic orders, worklists
    - Dataflow, tracking
    - Avoid manual entry, custom interfaces
    - “Close the loop”
  - Value proposition
    - Reduce errors
    - Improve throughput
    - Reduce costs

- Patient Info Reconciliation (PIR)
  - Patient identity changes
  - ADT, HIS, RIS, PACS
  - “Second half of SWF”
    - Propagate and coordinate demographic changes
    - Keep all systems on the same page
  - Value proposition
    - Reduce errors
    - Improve throughput
    - Reduce costs
Participate!

DICOM & IHE invite new members & contributors

• Application process; Patent disclosure policy

• dicom.nema.org
• dicom@medicalimaging.org
• www.ihe.net
• radiology@ihe.net

Great opportunity to learn
Great opportunity to contribute
Questions?