Deploying DICOM Effectively: Some Assembly Required

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Deploying DICOM Effectively

Primary Topics:
• Planning
• Purchasing
• Installing
• Maintaining
• Troubleshooting
• Studying
Hospitals are like children:

Each one is unique

But in many ways they are much alike

... and so are clinics, imaging centers, etc.
Own your architecture

• Base it on standards
• Choose the pieces that meet your needs
• Understand the “Big Picture”
• Balance unique needs & standard benefits

Identify the owner

• Staff, consultant, or long term vendor
• Ongoing initiative; not “One-and-Done”
Can I just ask for “DICOM”?
• Yes, if you don’t care what pieces you get
• Pieces can be implemented independently
• Depends on what the product needs to do

Won’t vendors just give me what I need?
• (We try to, but …) your input matters
• DICOM has it ≠ vendors use it (intelligently)

Know what is possible
Ask about your top priorities
IHE Profiles as Models

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

www.ihe.net -> User Handbooks
IHE Scheduled Workflow

HIS
- Registration
  - patient information

Orders Placed
- examination orders

RIS
- Orders Placed
  - Orders Filled

PACS
- IHE Scheduled Workflow
  - Report
    - Report Repository
      - Diagnostic Workstation
        - Film Lightbox
          - Film
    - Image Manager & Archive
      - Film Folder
        - Film

Modality
- Acquisition Modality
  - acquisition completed
    - acquisition
  - images stored
    - images
  - images printed
IHE Profiles as Models

Other Profiles address:
- Radiation Exposure Monitoring (REM)
- Post-Acquisition Workflow (PAWF)
- Portable Data for Imaging (PDI)
- Cross-enterprise Image Sharing (XDS-I.b)

wiki.ihe.net -> Integration Profiles (Catalog)
PACS is a Major Catalyst

- When buying a PACS system, you use DICOM to integrate:
  - Modalities (e.g. CT, MRI, X-ray, US, NM, etc.)
  - Workstations (3D, CAD, Review, etc.)
  - Radiology Information Systems (RIS)
  - Printers (color and grayscale)
  - Others

*Commonly known by most hospitals*
Key DICOM Features

- **Basic DICOM features:**
  - Send and receive images
  - Query and Retrieve from an archive
  - Download Patient information to modalities
  - Print images

- **Not so basic DICOM features:**
  - Reliable storage of images
  - Track image acquisition workflow
  - Store images as viewed by clinician
  - Generate and display reports
  - Tag important images
  - Others

*Only basics commonly known by most hospitals*
• This is a problem for hospitals that do not know how to speak “DICOM”
  – SOP Classes
  – Information Objects
  – Service Class User, Service Class Provider
  – Storage Commitment
  – Presentation State
  – Etc.
Integration Services

- Professional services offered by vendors and consultants
- Vendors understand their products and can typically tailor the integration better to their systems
- Independent consultants typically understand many products and can typically better employ best of breed solutions and help with “finger pointing”

Both types of consulting services can greatly increase the probability of a successful outcome.
Mainstream IT

- DICOM uses standard network technology
  - this skill is very important
- Need to understand
  - TCP/IP, routers, hubs, switches, cables, subnets

- Archive technology important
  - RAIDs, Magnetic Tape, Cloud
  - How much on-line storage do you need
Purchasing
“Translate” required hospital features into SOP Classes (or IHE Profiles)

Need
“"I want my modalities to integrate patient information with my RIS”"

Translation
“"RIS shall support Modality Worklist Information Model – FIND SOP Class as an SCP”"
“"Modality shall support Modality Worklist Information Model – FIND SOP Class as an SCU”"

OR
“"RIS and Modality shall support IHE Scheduled Workflow”"

**Important education for PACS Administrators**
DICOM Conformance Statements

- Documents how product implemented DICOM
- Required, Public, often on Web sites
- Well-defined format
- Facilitates comparisons of products
- Detailed information aids a knowledgeable DICOM person greatly
At a minimum, hospitals (PACS administrators) need to read SOP Class Tables

This Application Entity provides Standard Conformance to the following DICOM V3.0 SOP Classes as an SCU:

<table>
<thead>
<tr>
<th>SOP Class Name (SCU)</th>
<th>SOP Class UID</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR Image Storage</td>
<td>1.2.840.10008.5.1.4.1.1.4</td>
</tr>
<tr>
<td>Secondary Capture Image Storage</td>
<td>1.2.840.10008.5.1.4.1.1.7</td>
</tr>
<tr>
<td>Modality Worklist Management - FIND</td>
<td>1.2.840.10008.5.1.4.31</td>
</tr>
<tr>
<td>Modality Performed Procedure Step</td>
<td>1.2.840.10008.3.1.2.3.3</td>
</tr>
</tbody>
</table>

Compare a product’s SCU table with another’s SCP table
## New DCS format Executive Overview

<table>
<thead>
<tr>
<th>SOP Classes</th>
<th>User of Service (SCU)</th>
<th>Provider of Service (SCP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Image Transfer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT Image Storage</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Query/Retrieve</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Root Information Model FIND</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Study Root Information Model Move</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Workflow Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modality Worklist Information Model - Find</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>....</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Print Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basics Grayscale Print Mgt.</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>....</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Radiology Information System (RIS)

<table>
<thead>
<tr>
<th>Required Features</th>
<th>Optional Features</th>
</tr>
</thead>
</table>

Provide scheduled patient and exam info to modalities
- Modality Work-list SCP

Receive and process updates from Modalities
- MPPS SCP
Receive and store acquired images
- Storage SCP

Respond to queries for patient studies/images
- Query/Retrieve SCP
- Storage SCU

Print images
- Print SCU

Provide conformation of storage
- Storage Commitment SCP
Modalities

Query for Patients and exams to be performed
- Modality Work-list SCU

Send acquired images to PACS for storage
- Storage SCU

Print acquired images
- Print SCU

Query for prior exams
- Query/Retrieve SCU

Confirm storage of images on PACS
- Storage Commitment SCU

Update RIS on progress of exams
- MPPS SCU

Send Radiation Dose information
- Dose SR SCU

Required Features
Optional Features
Workstations

• Quality Assurance Workstation
  – Image Storage SOP Classes (Various) – SCU/SCP
  – Study Root Query/Retrieve Information Model – Find – SCU
  – Study Root Query/Retrieve Information Model – Move – SCU
  – Basic Grayscale and/or Color Print Mgt Meta SOP Class –SCU
  – Grayscale Softcopy Presentation State – SCU/SCP
  – DICOM SRs (Various) – SCU/SCP
  – Others

• Film Digitizer
  – Secondary Capture Image Storage – SCU
  – Modality Worklist Information Model – Find – SCU
  – Storage Commitment Push Model SOP Class – SCU
DICOM Storage – “push” images

- Question for archives, workstations and modalities

PACS Vendors say “We support Storage”

- At a minimum it usually means, CT, X-ray, CR, MR, US, Secondary Capture (for a PACS)
- But you need to ask, does it include MG (mammo), NM, PET, Color US, Cardiac Echo (US multi-frame)?

Specific to the modality (e.g. a CT image is NOT a US image)

- Send CT Images – CT Image Storage SOP Class – SCU
- Receive CT Images – CT Image Storage SOP Class - SCP
Query/Retrieve – “pull” images from archive
• Question for archives, workstations and some modalities

Many PACS don’t use DICOM with own workstations
• Q/R is often only used with 3rd party workstations, such as 3D, NM workstation, etc.
• Workstation asking query
  • Study Root Query/Retrieve Information Model – Find – SCU
• Archive being queried
  • Study Root Query/Retrieve Information Model – Find – SCP

Print – one simple question, Black/White (grayscale) and/or Color (RBG)
• Modality or Workstation – Basic Grayscale Print Management Meta SOP Class – SCU
• Printer - Basic Grayscale Print Management Meta SOP Class – SCP
Guarantee secure storage of data on archive
Real feature is to manage disk space on modality

- Automatically delete images on modality?
- User interfaces makes deletion easy?
- Modalities do Storage Commitment but do nothing?
- Modality – Storage Commitment Push Model SOP Class – SCU
- Archive - Storage Commitment Push Model SOP Class – SCU

Difficult for hospitals to understand because they don’t see the workflow.
“I’m interested in IHE Profile X. Who does it?”

- **Testing Database:**
  - IHE Connectathons – Comprehensive
  - Lists Vendor Names
  - [http://connectathon-results.ihe.net](http://connectathon-results.ihe.net)

- **Product Database**
  - IHE Integration Statements – Voluntary
  - Specific Products / Versions
  - [http://product-registry.ihe.net](http://product-registry.ihe.net)
Installing
Configuration

• DICOM network configuration
  – AE Title, Port Numbers, IP Address
  – Prone to human error; be diligent

• System Specific Details
  – Procedure Code Lists
  – Acquisition Protocols
  – User lists
  – Etc.

• Be prepared to communicate these details to your vendor before installation
Acceptance Testing

• Have a plan
  – Vendors will test some things
  – Know what is important to test for you

• Be prepared to communicate these details to your vendor before installation

• There are public tools that can be helpful (See “Tools for DICOM”)

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Deploying DICOM Effectively
Maintaining

• Display Calibration
  – DICOM Greyscale Display Function

• Configuration Evolution
  – New Procedure Codes
  – New Acquisition Protocols
  – New User lists
  – Etc.

• Software Upgrades
  – Can be as involved as initial installation
• There are public tools that can be very helpful (See “Tools for DICOM”)
  – Network sniffers
  – DICOM object viewers
  –Validators
  – DVTK
• Society for Imaging Informatics in Medicine
  – http://www.siimweb.org/
  – Growing set of “Need To Know ePubs”

  – Imaging Informatics Professional (IIP)
    • Training and Certification

  – Practical Imaging Informatics: Foundations and Applications for PACs Professionals
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Thank you for your attention !